COMPARATIVE STUDY REGARDING THE USE OF CYANOACRYLATE GLUE AND SUBCUTICULAR SUTURES IN THYROIDECTOMY WOUND CLOSURE

M.S. DEGREE EXAMINATION

BRANCH I - GENERAL SURGERY

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Madurai – 20

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CHENNAI, INDIA.

CERTIFICATE BY THE GUIDE

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CONTENTS

INTRODUCTION

Surgeon is known by the scar he gives"; this is a quote, we are quite familiar with. With times changing, one thing has not changed is the desire to look better. Since time immemorial, surgeons have struggled to produce **invisible scars.** Over the time wound closure techniques have evolved from the earliest suturing materials to synthetic absorbable sutures, staples, tapes, and adhesive compounds. The ideal method of incision closure has to be simple, safe, rapid, inexpensive, painless, bactericidal, and result in optimal cosmetic appearance of the scar.

Thyroid surgeries are one of the most commonly performed by a general surgeon. Surgery in this region also arises significant aesthetic problems because this is the region most exposed to others and therefore very important. These surgeries classically require anterior neck incisions that are at the risk of undesirable aesthetic results when scars do not form as expected.

Moreover these surgeries are practiced in young women and the incidence of thyroid disease is three times more in women than men. Also incidences peaks in third and fourth decades of life. For all these reasons the cosmetic outcomes of this kind of surgery is very important.

Closure of wounds to achieve an aesthetically pleasing scar has always been a challenge. Surgeons have been trying to produce invisible scars. Wound closure has extended from suturing materials to absorbable sutures, tapes and adhesive compounds.

Early and uncomplicated wound healing has been a subject of interest over the ages. An ideal method of incision closure should be simple, safe, rapid, inexpensive, painless, and bactericidal and result in optimal cosmetic appearance of the scar. In general, wound closure biomaterials are divided into three major categories: Suture materials, staples and tissue adhesives. Suturing has been the most widely used method for wound closure because of high reliability of suture materials. However, alternative techniques have long been sought, since suturing technique requires skill and experience, a relatively longer time and the need for its removal.

The use of octyl- cyanoacrylate adhesives is been extensively used for diverse applications like tissue adhesion, haemostasis, wound closure, closure of CSF leaks, vascular embolisation and application of skin grafts.

Henceforth, keeping in mind the changing cosmetic expectations of patients this study was designed to compare the efficacy of OCTYL-CYANOACRYLATE with that of subcuticular sutures in thyroidectomy skin closure.

RESEARCH PROPOSAL

Aim of the study:

To study the efficacy of Cyanoacrylate glue in comparison to routinely used subcuticular sutures in thyroidectomy wound closure in GRH, Madurai.

Objectives:

A comparison regarding cyanoacrylate glue and subcuticular suture in thyroidectomy wound closure in view of the following parameters:

- Time taken in the closure of wound intraoperative.
- Wound Infection and Dehiscence postoperatively.
- Scar Cosmesis.

Eligibility criteria

Inclusion criteria:

- Age group from 17 to 70 years.
- All patients undergoing thyroidectomy surgeries (including total and hemi-thyroidectomy surgeries).
- All patients willing for follow-up up to 6 months.

Exclusion criteria:

- Patients with diabetes mellitus, HIV, Immunocompromised status.
- Patient not consented for inclusion in the study.
- Patients with history of allergic disorders.
- Patients with history of previous thyroid surgeries.
- Incisions which require to be closed under tension.
- Patients undergoing thyroidectomy for malignancy with neck dissection or recurrence.
- Patients with known personal history of scar hypertrophy or keloid formation.

DESIGN OF STUDY: Prospective Study

PERIOD OF STUDY: 2 Years

SELECTION OF STUDY SUBJECTS: Age between 17 and 70 years in both sexes, patients undergoing thyroidectomy surgery in GRH, Madurai.

DATA COLLECTION: Data regarding History, surgery done and outcome.

METHODS: Observation study

ETHICAL CLEARANCE: Approval obtained.

CONSENT: Informed and written consent from all patients.

ANALYSIS: using CHI SQUARE test – p value

CONFLICT OF INTEREST: none

FINANCIAL SUPPORT: NIL FROM THE INSTITUTION

PARTICIPANTS: Any case of thyroidectomy irrespective of sex and occupation were included in the study, (excluding the patients who have co-morbidities like Diabetes Mellitus, Systemic Hypertension, HIV, immunosuppressed status etc.).

Materials used:

1. Cyanoacrylate Glue

2. Prolene for subcuticular sutures

REVIEW OF LITERATURE

The term thyroid was derived from the word THYREOIEDES which means a shield shaped gland in the anterior aspect of Neck. Thyroid was being studied from 16^{th} to 17^{th} centuries but the function was never understood at that time. Later by 19^{th}-century pathologic enlargement of thyroid that is goitre was described and seaweed which was rich in Iodine was used as a treatment.

In the 19 century in the later part two surgeons and physiologists revolutionised the understanding and treatment of thyroid disease. Bill Roth and Kocher applied surgical technique for benign and malignant thyroid disease. Kocher received the noble prize in 1909 for his pioneering works in the understanding of Thyroid physiology and surgery.

Thyroid is the gland that embryologically originates from the foramen cecum of the base of the tongue. It slowly descends into the neck and forms the bilobed organ. This descending pathway of the thyroid forms the thyroglossal duct which is commonly absorbed by six weeks of age. This distal aspect of the pathway if retained forms the pyramidal lobe.

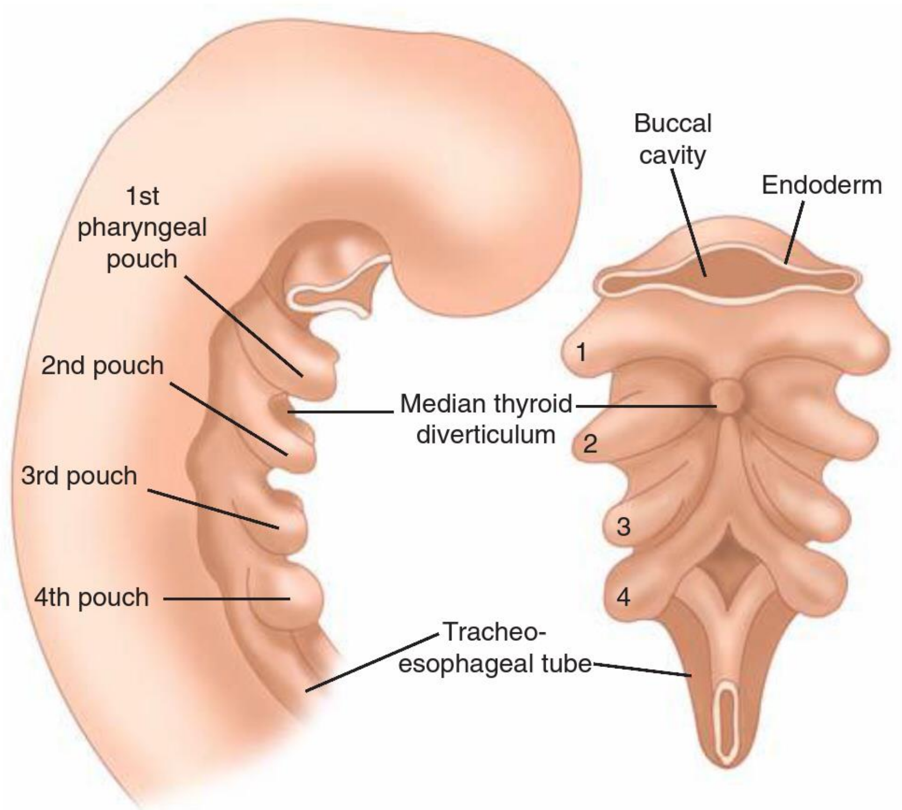


Fig: 1 Thyroid embryology—early development of the median thyroid anlage as a pharyngeal pouch

Calcitonin producing C cells arising in the fourth pharyngeal pouch migrate into the lateral and posterior Upper two thirds of the thyroid lobes.

The embryological origin and descent of thyroid is associated with various anomalies. Athyreosis is the total absence of lateral lobes and isthmus with hypothyroidism. Thyroglossal duct cysts and fistula occur due to retained tissue along the path of the descent of thyroid. Lingual thyroid is another condition that occurs when the median thyroid does not descend in a normal fashion.

Ectopic thyroid tissue maybe found at times in the central compartment of the neck, lower poles of the normal thyroid and sometimes in the anterior mediastinum. Initially ectopic thyroid tissues found in the lateral neck compartment was known as lateral aberrant thyroid, but at present thyroid tissue present lateral to the jugular vein is considered as metastatic deposits from the differentiated thyroid carcinoma (DTC).

ANATOMY OF THYROID GLAND

A normal adult thyroid weighs about10 to 20g. Thyroid is a bilobed structure which is lying next to the thyroid cartilage and anterolateral to laryngo-tracheal junction. Thyroid encircles approximately 75% of the laryngo tracheal junction. Thyroid lobes are present lateral to the trachea and oesophagus, antero medial to the carotid sheath and is posteromedial to the sternocleidomastoid, sternohyoid and sternothyroid muscles.

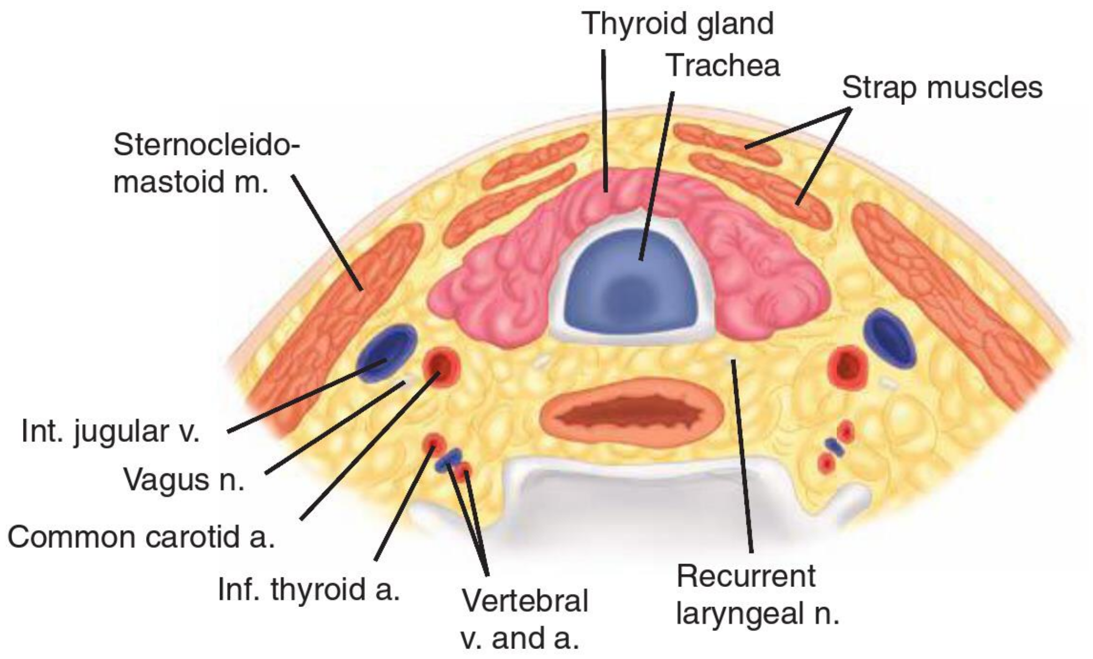


Fig: 2 Anatomy of the thyroid gland and surrounding structures, viewed in cross-section.

The two lobes of the thyroid are joined together by the isthmus and is situated at or just below the cricoid cartilage. A thin layer of connective tissue surrounds the thyroid. This tissue is part of the fascial layer that invests the trachea. This fascia coalesces with the thyroid capsule posteriorly and laterally to form a suspensory ligament termed as the **ligament of Berry**, which is the primary point of fixation of the thyroid to surrounding structures. The ligament of Berry is closely attached to the cricoid cartilage.

The thyroid gland is related to two important nerves. **The superior laryngeal nerve** is a branch of the vagus that separates from the vagus nerve at the base of the skull and comes down towards the superior pole of the thyroid medial to the carotid sheath. At the level of the cornu of the hyoid, it divides into two branches. The larger internal branch which penetrates the thyrohyoid membrane and provides sensory innervation to the larynx cranial to the vocal folds. The smaller external branch continues along the lateral surface of the inferior pharyngeal constrictor muscle and descends anteriorly and medially along with the superior thyroid artery. Within 1 cm of the entrance into the thyroid capsule, the nerve generally takes a medial course and pierces the cricothyroid muscle, which it innervates. This nerve is at risk of being severed if the superior pole vessels are ligated at a distance above the superior pole of the thyroid. Damage to the external branch results in loss of voice quality or strength.[16]

The Recurrent laryngeal nerves are so named because of their course. They course cranial after branching from the vagus caudally. On the right side, the RLN originates from the vagus nerve. It crosses anterior to the subclavian artery. The right RLN can usually be found within one cm lateral to or within the tracheoesophageal groove. The nerve can usually be found immediately anterior or posterior to a main arterial trunk of the inferior thyroid artery. On the left side, the RLN separates from the vagus as that nerve passes anterior to the arch of the aorta. The left RLN passes inferior and posteromedial to the aorta at the ligamentum arteriosum and begins to ascend toward the larynx. It enters the tracheoesophageal groove as it ascends to the level of the lower pole of the thyroid. Both RLNs are consistently found within the tracheoesophageal groove when they are within 2.5 cm of their entrance into the larynx.

The RLN has mixed motor, sensory, and autonomic functions and innervates the intrinsic laryngeal muscles. Damage to a RLN results in the paralysis of the vocal cord on the affected side. Such damage might result in a cord that remains in a midline position or a paramedian position. If the vocal cord remains paralyzed in an abducted position and closure cannot occur, a severely impaired voice and ineffective cough also may result. If the RLNs are damaged bilaterally, complete loss of voice or airway obstruction may occur and possibly require an emergency surgical airway. Occasionally, bilateral damage can result in cords taking an abducted position; although this allows airway movement, it may result in upper respiratory infection as a result of ineffective cough and aspiration.

The arterial supply to the thyroid gland consists of four main arteries. The **superior thyroid artery** is the first branch of the external carotid artery after the bifurcation of the common carotid artery. The superior thyroid artery and external branch of the superior laryngeal nerve lie immediately deep to the sternothyroid muscle as this muscle inserts on the thyroid cartilage. **The inferior thyroid artery** originates from the thyrocervical trunk. It originates from the subclavian artery and ascends into the neck on either side posterior to the carotid sheath and then arches medially and enters the thyroid gland posteriorly, usually near the ligament of Berry. Despite the name “inferior thyroid artery,” no direct arterial supply generally enters the inferior aspect of the thyroid. However, an **arteria thyroidea ima** may be present in less than 5% of patients and usually arises directly from the innominate artery or from the aorta. The inferior thyroid artery has important anatomic relationships. The RLN is usually directly adjacent (in either an anterior or a posterior position) to the inferior thyroid artery, within 1 cm of its entrance into the larynx. Careful dissection of the artery is mandatory and cannot be completed until the position of the RLN is absolutely defined. Additionally, the inferior thyroid artery typically supplies the superior and the inferior parathyroid glands, and care must be taken to evaluate the parathyroids after division of the inferior thyroid artery. For this reason, the inferior thyroid artery should be divided at the distal branches into the thyroid, rather than at its main trunk.

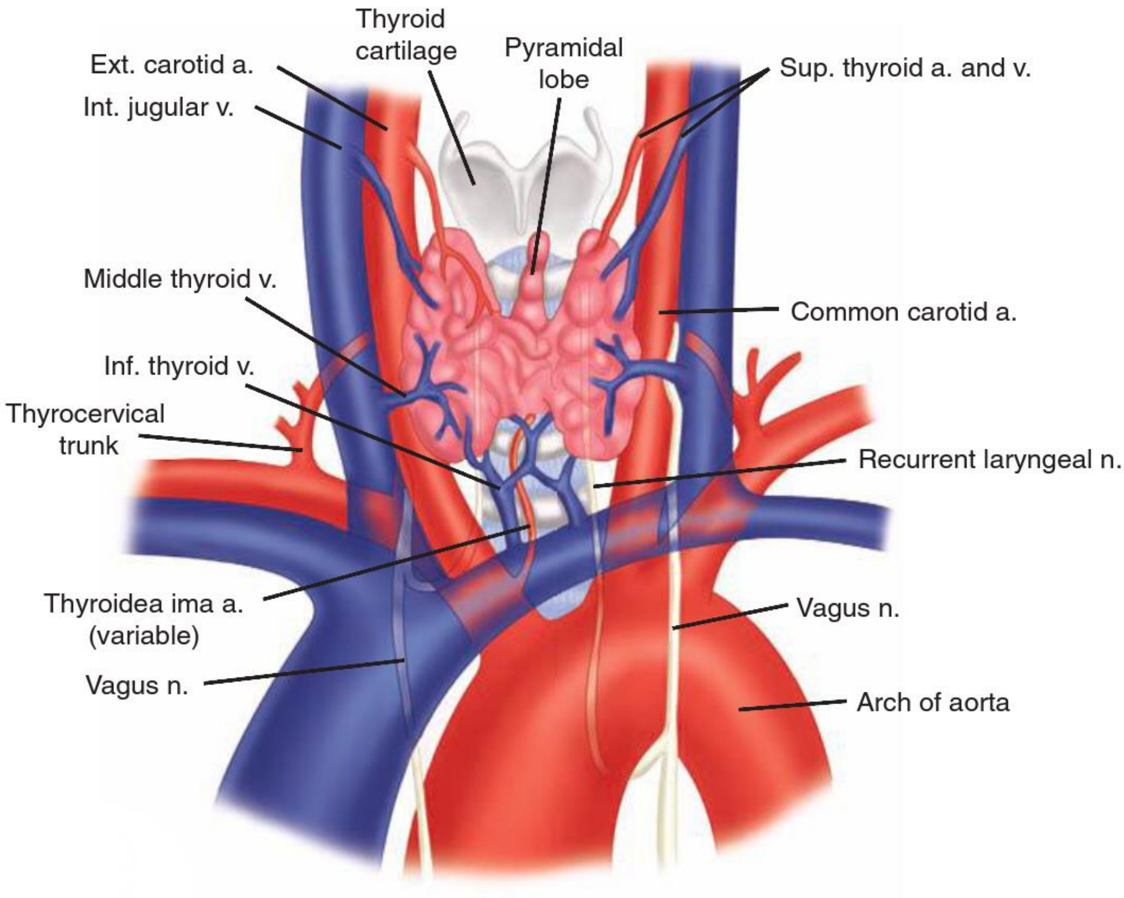


Fig: 3 Arterial and venous supply of the thyroid gland

Three pairs of venous systems drain the thyroid. **Superior venous drainage** is immediately adjacent to the superior arteries and joins the internal jugular vein at the level of the carotid bifurcation. **Middle thyroid veins** may be single or multiple and course immediately laterally into the internal jugular vein. The inferior thyroid veins are usually two or three in number and descend directly from the lower pole of the gland into the innominate and brachiocephalic veins. These veins often descend in association with the cervical horn of the thymus gland. The thyroid gland

and its neighbouring structures have rich lymphatics that drain the thyroid in almost every direction. Within the gland, lymphatic channels are present immediately beneath the capsule and communicate between lobes through the isthmus. This drainage connects to structures directly adjacent to the thyroid, with numerous lymphatic channels into the regional lymph nodes. It is useful clinically to divide the lymph nodes between the central and lateral neck, with the boundary between these marked by the carotid sheath. The lateral neck zones are further subdivided. Most thyroid cancers drain directly to central nodal basins (level VI) except for cancers in the superior third of the gland, which may drain directly to the lateral compartment (so-called skip metastases). Central compartment level VI lymph nodes include prelaryngeal nodes (also known as delphian nodes); pretracheal nodes inferior to the isthmus; paratracheal nodes; tracheoesophageal groove lymph nodes; The upper mediastinal nodes are variably considered as level VII or may be considered as part of level VI. The lateral neck nodes include levels II through V. It is important to use these anatomically defined compartments for clear communication between physicians as well as when performing lateral neck dissections.

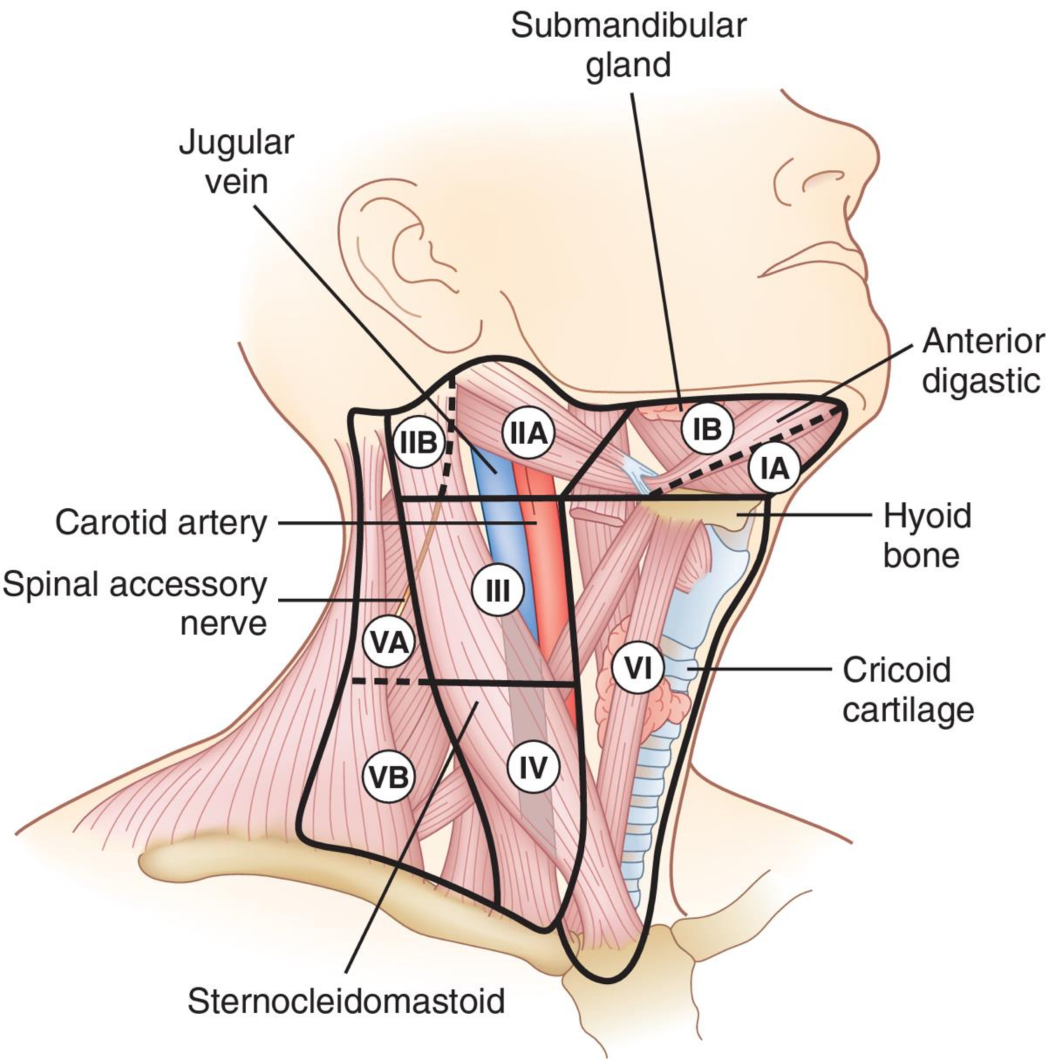


Fig: 4 Lymph node compartments separated into levels and sublevels.

Level VI contains the thyroid gland and the adjacent nodes bordered superiorly by the hyoid bone, inferiorly by the innominate (brachiocephalic) artery, and laterally on each side by the carotid sheaths. Level II, III, and IV nodes are arrayed along the jugular veins on each side, bordered anteromedially by level VI and laterally by the posterior border of the sternocleidomastoid muscle.

Level III nodes are bounded superiorly by the level of the hyoid bone and inferiorly by the inferior aspect of the cricoid cartilage; levels II and IV are above and below level III, respectively. The level I node compartment includes the submental and submandibular nodes, above the hyoid bone and anterior to the posterior edge of the submandibular gland. Level V nodes are in the posterior triangle, lateral to the lateral edge of the sternocleidomastoid muscle. Levels I, II, and V can be further subdivided as noted in the figure. The inferior extent of level VI is defined as the suprasternal notch.

ANATOMY OF SKIN

The skin is the largest organ of the body, with a total area of about 20 square feet. It is the outer covering of the body. In humans, it is the largest organ of the integumentary system. The skin has up to seven layers of ectodermal tissue and guards the underlying muscles, bones, ligaments and internal organs. Because it interfaces with the environment, skin plays an important immunity role in protecting the body against pathogens[5] and excessive water loss.[6] Its other functions are insulation, temperature regulation, sensation, synthesis of vitamin D, and the protection of vitamin B folates. Severely damaged skin will try to heal by forming scar tissue. This is often discolored and depigmented.

Layers of skin:

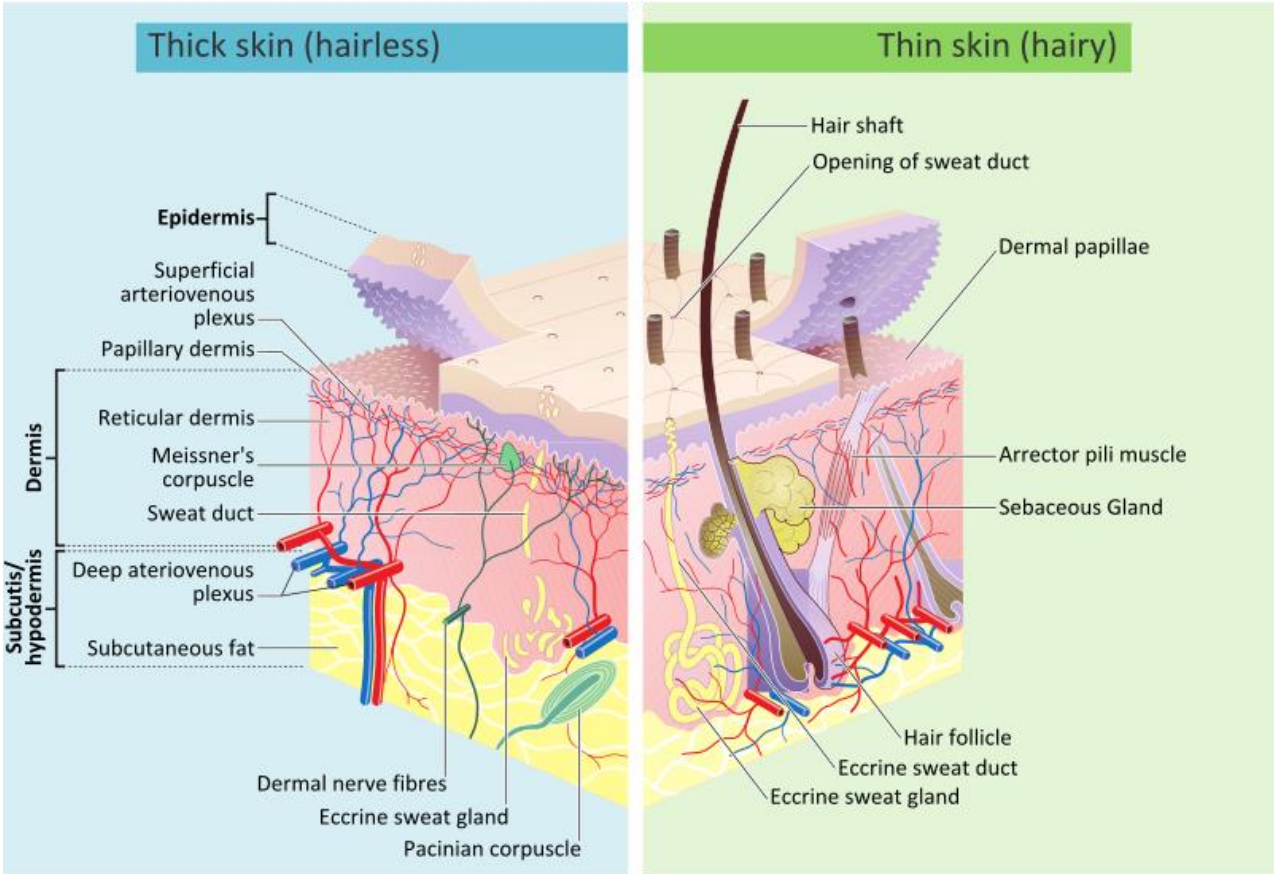


Fig 5: Showing layers of skin

The Epidermis

The epidermis is composed of keratinized, stratified squamous epithelium. It is made of four or five layers of epithelial cells, depending on its location in the body. It does not have any blood vessels within it (i.e., it is avascular). Skin that has four layers of cells is referred to as "thin skin." From deep to superficial, these layers are the stratum basale, stratum spinosum, stratum granulosum, and stratum corneum. Most of the skin can be classified as thin skin. “Thick skin” is found only on the palms of the hands and the soles of the feet. It has a fifth layer, called the stratum lucidum, located between the stratum corneum and the stratum granulosum. The cells in all of the layers except the stratum basale are called keratinocytes. A **keratinocyte** is a cell that manufactures and stores the protein keratin. **Keratin** is an intracellular fibrous protein that gives hair, nails, and skin their hardness and water-resistant properties. The keratinocytes in the stratum corneum are dead and regularly slough away, being replaced by cells from the deeper layers

Stratum Spinosum

As the name suggests, the **stratum spinosum** is spiny in appearance due to the protruding cell processes that join the cells via a structure called a **desmosome**. The desmosomes interlock with each other and strengthen the bond between the cells. It is interesting to note that the “spiny” nature of this layer is an artifact of the staining process. Unstained epidermis samples do not exhibit this characteristic appearance. The stratum spinosum is composed of eight to 10 layers of keratinocytes, formed as a result of cell division in the stratum basale. Interspersed among the keratinocytes of this layer is a type of dendritic cell called the **Langerhans cell**, which functions as a macrophage by engulfing bacteria, foreign particles, and damaged cells that occur in this layer.

The keratinocytes in the stratum spinosum begin the synthesis of keratin and release a water-repelling glycolipid that helps prevent water loss from the body, making the skin relatively waterproof. As new keratinocytes are produced atop the stratum basale, the keratinocytes of the stratum spinosum are pushed into the stratum granulosum.

Stratum Granulosum

The **stratum granulosum** has a grainy appearance due to further changes to the keratinocytes as they are pushed from the stratum spinosum. The cells (three to five layers deep) become flatter, their cell membranes thicken, and they generate large amounts of the proteins keratin, which is fibrous, and **keratohyalin**, which accumulates as lamellar granules within the cells. These two proteins make up the bulk of the keratinocyte mass in the stratum granulosum and give the layer its grainy appearance. The nuclei and other cell organelles disintegrate as the cells die, leaving behind the keratin, keratohyalin, and cell membranes that will form the stratum lucidum, the stratum corneum, and the accessory structures of hair and nails.

Stratum Lucidum

The **stratum lucidum** is a smooth, seemingly translucent layer of the epidermis located just above the stratum granulosum and below the stratum corneum. This thin layer of cells is found only in the thick skin of the palms, soles, and digits.

The keratinocytes that compose the stratum lucidum are dead and flattened (see Figure 4). These cells are densely packed with **eleiden**, a clear protein rich in lipids, derived from keratohyalin, which gives these cells their transparent (i.e., lucid) appearance and provides a barrier to water.

Stratum Corneum

The **stratum corneum** is the most superficial layer of the epidermis and is the layer exposed to the outside environment (see Figure 4). The increased keratinization (also called cornification) of the cells in this layer gives it its name. There are usually 15 to 30 layers of cells in the stratum corneum. This dry, dead layer helps prevent the penetration of microbes and the dehydration of underlying tissues, and provides a mechanical protection against abrasion for the more delicate, underlying layers. Cells in this layer are shed periodically and are replaced by cells pushed up from the stratum granulosum (or stratum lucidum in the case of the palms and soles of feet). The entire layer is replaced during a period of about 4 weeks. Cosmetic procedures, such as microdermabrasion, help remove some of the dry, upper layer and aim to keep the skin looking “fresh” and healthy.

Dermis

The **dermis** might be considered the “core” of the integumentary system (derma- = “skin”), as distinct from the epidermis (epi- = “upon” or “over”) and hypodermis (hypo- = “below”). It contains blood and lymph vessels, nerves, and other structures, such as hair follicles and sweat glands. The dermis is made of two layers of connective tissue that compose an interconnected mesh of elastin and collagenous fibers, produced by fibroblasts

Papillary Layer

The **papillary layer** is made of loose, areolar connective tissue, which means the collagen and elastin fibers of this layer form a loose mesh. This superficial layer of the dermis projects into the stratum basale of the epidermis to form finger-like dermal papillae (see Figure 6). Within the papillary layer are fibroblasts, a small number of fat cells (adipocytes), and an abundance of small blood vessels. In addition, the papillary layer contains phagocytes, defensive cells that help fight bacteria or other infections that have breached the skin. This layer also contains lymphatic capillaries, nerve fibers, and touch receptors called the Meissner corpuscles.

Reticular Layer

Underlying the papillary layer is the much thicker **reticular layer**, composed of dense, irregular connective tissue. This layer is well vascularized and has a rich sensory and sympathetic nerve supply. The reticular layer appears reticulated (net-like) due to a tight meshwork of fibers. **Elastin fibers** provide some elasticity to the skin, enabling movement. Collagen fibers provide structure and tensile strength, with strands of collagen extending into both the papillary layer and the hypodermis. In addition, collagen binds water to keep the skin hydrated. Collagen injections and Retin-A creams help restore skin turgor by either introducing collagen externally or stimulating blood flow and repair of the dermis, respectively.

Hypodermis

The **hypodermis** (also called the subcutaneous layer or superficial fascia) is a layer directly below the dermis and serves to connect the skin to the underlying fascia (fibrous tissue) of the bones and muscles. It is not strictly a part of the skin, although the border between the hypodermis and dermis can be difficult to distinguish. The hypodermis consists of well-vascularized, loose, areolar connective tissue and adipose tissue, which functions as a mode of fat storage and provides insulation and cushioning for the integument.

BLOOD SUPPLY OF SKIN (NECK)

Skin around the neck is highly vascular**.** Myocutaneous perforators passing from the sternocleidomastoid, strap muscles, and trapezius supply the dermal-subdermal plexus. Also, there are consistently identifiable branches of the superior thyroid, posterior auricular, occipital, facial and transverse cervical arteries, which supply both the platysmal vascular plexus and the overlying dermal-subdermal plexus. The dermal-subdermal plexus is continuous across the midline and this contralateral pathway is supplied chiefly from branches of the superior thyroid artery, facial artery, and myocutaneous perforators of the strap muscles as shown in Figure 6. This information may be useful in the planning of cervical incisions and the design of platysma myocutaneous flaps.

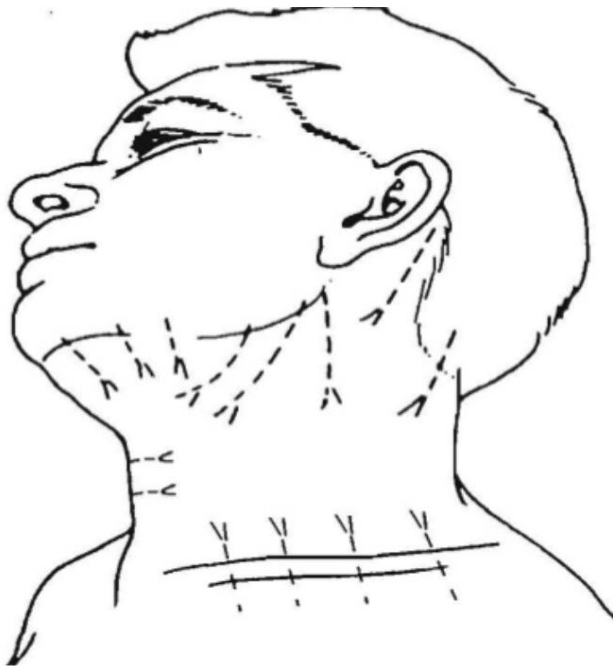


Fig 6: Shows the blood supply of the skin of the Neck

WOUND HEALING:

Wound healing is a complex and dynamic process with the wound environment changing with the changing health status of the individual. It’s a complex series of events that begins at the moment of injury and can continue for months to years. Tremendous advancements have been made in understanding the process of wound healing. The cell types and the order in which they appear in the wound have been established, many growth factors and their functions have been elucidated. An incision created by a scalpel, trauma resulting from a bullet or tissue death caused by a myocardial infarction, all undergo a similar and predictable reparative process. The three categories of wound healing are primary, secondary and tertiary. Primary healing involves closure of a wound within hours of its creation, repairing a full thickness surgical incision. Secondary healing involves no formal wound closure; the wound closes spontaneously by contraction and re- epithelialization. Secondary healing results in an inflammatory response that is more intense than with primary wound healing. In addition, a larger quantity of granulomatous tissue is fabricated because of the need for wound closure. Secondary healing results in pronounced contraction of wounds.

Tertiary wound closure, also known as delayed primary closure involves initial debridement of the wound for an extended period and then formal closure with suturing or by another mechanism. This type of healing may be desired in the case of contaminated wounds. By the fourth day, phagocytosis of contaminated tissues is well underway, and the processes of epithelialization, collagen deposition and maturation are occur. There are four distinct but overlapping phases of wound healing which include:

- Haemostasis phase
- Inflammatory phase

- Proliferative phase
- Remodelling phase

Haemostasis Phase:

Hemostasis starts within the very first moments of the injury, where platelets play a role by aggregating, as well as by releasing cytokines, chemokines, and hormones.

Vasoconstriction occurs to limit blood loss under the effects of vasoactive mediators (epinephrine, norepinephrine, prostaglandins, serotonin, and thromboxane), causing temporary blanching of the wound.

Exposed sub endothelium, including collagen and tissue factor, activates platelet aggregation and leads to clot formation (primary plug).

Aggregation and attachment to exposed collagen surfaces activates the platelets.

Activation enables platelets to degranulate and release chemotactic and growth factors, such as platelet-derived growth factor (PDGF), proteases, and vasoactive agents (eg, serotonin, histamine).

Chemokines released by platelet activation attract inflammatory cells to the area, leading to the next phase in the healing process.

Inflammatory Phase

In addition to activation of fibrin, thrombin activated by the coagulation cascades facilitates migration of inflammatory cells to the site of injury by increasing vascular permeability. By this mechanism, factors and cells necessary for healing flow from the intravascular space and into the extravascular space.

At this time, clot formation dissipates as its stimuli dissipate. Plasminogen is converted to plasmin, a potent enzyme that aids in cell lysis.

The initial vasoconstriction period, typically only 10-15 minutes in duration, is followed by a more persistent period of vasodilation mediated by histamine, prostaglandins, kinins, and leukotrienes. Vasodilation is an important means by which the wound can be exposed to increased blood flow, accompanied by the necessary inflammatory cells and factors that fight infection and debride the wound of devitalized tissue. Alterations in pH (secondary to tissue and bacterial degradation), swelling, and tissue hypoxemia at the injury site contribute to the sensation of wound pain.

The cellular aspect of the inflammatory phase occurs within hours of injury, and it includes neutrophils, macrophages, and lymphocytes.

Neutrophils are the predominant cell type for the first 48 hours after injury but do not appear essential to the wound-healing process. Neutrophils cleanse the wound site of bacteria and necrotic matter and release inflammatory mediators and bactericidal oxygen free radicals. The absence of neutrophils does not prevent healing.

Macrophages are essential to wound healing and perhaps are the most important cells in the early phase of wound healing. [1] Macrophages phagocytose debris and bacteria. Macrophages also secrete collagenases and elastases, which break down injured tissue and release cytokines. In addition, macrophages release PDGF, an important cytokine that stimulates the chemotaxis and proliferation of fibroblasts and smooth muscle cells. Finally, macrophages secrete substances that attract endothelial cells to the wound and stimulate their proliferation to promote angiogenesis. Macrophage-derived growth factors play a pivotal role in new tissue formation, as evidenced by the fact that new tissue formation in macrophage-depleted animal wounds demonstrates defective repair. In studies in which experimental wounds are rendered monocytopenic, subsequent stages of fibroplasia and granulation tissue formation are impaired and the overall rate of wound healing is delayed.

T lymphocytes migrate into the wound during the inflammatory phase, approximately 72 hours following injury. T lymphocytes are attracted to the wound by the cellular release of interleukin 1, which also contributes to the regulation of collagenase. Lymphocytes secrete lymphokines such as heparin-binding epidermal growth factor and basic fibroblast growth factor. Lymphocytes also play a role in cellular immunity and antibody production.

Proliferative Phase

Formation of granulation tissue is a central event during the proliferative phase. Its formation occurs 3-5 days following injury and overlaps with the preceding inflammatory phase. Granulation tissue includes inflammatory cells, fibroblasts, and neovasculature in a matrix of fibronectin, collagen, glycosaminoglycans, and proteoglycans.

Epithelialization:

Epithelialization is the formation of epithelium over a denuded surface. It involves the migration of cells at the wound edges over a distance of less than 1 mm, from one side of the incision to the other. Incisional wounds are epithelialized within 24-48 hours after injury. This epithelial layer provides a seal between the underlying wound and the environment.

The process begins within hours of tissue injury. Epidermal cells at the wound edges undergo structural changes, allowing them to detach from their connections to other epidermal cells and to their basement membrane. Intracellular actin microfilaments are formed, allowing the epidermal cells to creep across the wound surface. As the cells migrate, they dissect the wound and separate the overlying eschar from the underlying viable tissue. In superficial wounds (eg, wounds due to laser resurfacing, dermabrasion, chemical peel treatments) adnexal structures (eg, sebaceous glands, hair follicles) contribute to reepithelialization.

Epidermal cells secrete collagenases that break down collagen and plasminogen activator, which stimulates the production of plasmin. Plasmin promotes clot dissolution along the path of epithelial cell migration. Migrating epithelial cells interact with a provisional matrix of fibrin cross-linked to fibronectin and collagen. In particular, fibronectin seems to promote keratinocyte adhesion to guide these cells across the wound base.

Wounds in a moist environment demonstrate a faster and more direct course of epithelialization. Occlusive and semiocclusive dressings applied in the first 48 hours after injury may maintain tissue humidity and optimize epithelialization. Studies have shown that occlusive dressings in the form of silicone sheeting, or other forms of occlusive dressing, limit epidermal inflammatory factors that contribute to epidermal hyperplasia, by restoring barrier function and increasing skin hydration.

When epithelialization is complete, the epidermal cell assumes its original form, and new desmosomal linkages to other epidermal cells and hemidesmosomal linkages to the basement membrane are restored.

Fibroplasia:

The fibroblast is a critical component of granulation tissue. Fibroblasts are responsible for the production of collagen, elastin, fibronectin, glycosaminoglycans, and proteases Fibroblasts grow in the wound as the number of inflammation cells decrease. The demand for inflammation disappears as the chemotactic factors that call inflammatory cells to the wound are no longer produced and as those already present in the wound are inactivated.

Fibroplasia begins 3-5 days after injury and may last as long as 14 days. Skin fibroblasts and mesenchymal cells differentiate to perform migratory and contractile capabilities. Fibroblasts migrate and proliferate in response to fibronectin, platelet-derived growth factor (PDGF), fibroblast growth factor, transforming growth factor, and C5a. Fibronectin serves as an anchor for the myofibroblast as it migrates within the wound.

The synthesis and deposition of collagen is a critical event in the proliferative phase and to wound healing in general. Collagen is rich in hydroxylysine and hydroxyproline moieties, which enable it to form strong cross-links. The hydroxylation of proline and lysine residues depends on the presence of oxygen, vitamin C, ferrous iron, and α-ketoglutarate. Deficiencies of oxygen and vitamin

C, in particular, result in underhydroxylated collagen that is less capable of forming strong cross-links and, therefore, is more vulnerable to breakdown. Collagen is secreted to the extracellular space in the form of procollagen. This form is then cleaved of its terminal segments and called tropocollagen. Tropocollagen can aggregate with other tropocollagen molecules to form collagen filaments.

Filament, fibril, and fiber formation occur within a matrix gel of glycosaminoglycans, hyaluronic acid, chondroitin sulfate, dermatan sulfate, and heparin sulfate produced by fibroblasts.

Intermolecular cross-links within the collagen fiber stabilize it, making it resistant to destruction. Age, tension, pressure, and stress affect the rate of collagen synthesis. Collagen synthesis begins approximately 3 days after injury and may continue at a rapid rate for approximately 2-4 weeks. Collagen synthesis is controlled by the presence of collagenases and other factors that destroy collagen as new collagen is made.

Approximately 80% of the collagen in normal skin is type I collagen; the remaining is mostly type III. In contrast, type III collagen is the primary component of early granulation tissue and is abundant in embryonic tissue. Collagen fibers are deposited in a framework of fibronectin. An essential interaction seems to exist between fibronectin and collagen; experimental wounds depleted of fibronectin demonstrate decreased collagen accumulation. Elastin is also present in the wound in smaller amounts. Elastin is a structural protein with random coils that allow for stretch and recoil properties of the skin.

Angiogenesis:

A rich blood supply is vital to sustain newly formed tissue and is appreciated in the erythema of a newly formed scar. The macrophage is essential to the stimulation of angiogenesis and produces macrophage-derived angiogenic factor in response to low tissue oxygenation. This factor functions as a chemoattractant for endothelial cells. Basic fibroblast growth factor secreted by the macrophage and vascular endothelial growth factor secreted by the epidermal cell are also important to angiogenesis.

Angiogenesis results in greater blood flow to the wound and, consequently, increased perfusion of healing factors. Angiogenesis ceases as the demand for new blood vessels ceases. New blood vessels that become unnecessary disappear by apoptosis.

Contraction:

Wound contraction, defined as the centripetal movement of wound edges that facilitates closure of a wound defect, essentially begins concurrent with collagen synthesis, and reaches maximal activity at 5-15 days after injury. Contraction results in a decrease in wound size, appreciated from end to end along an incision; a 2-cm incision may measure 1.8 cm after contraction. The maximal rate of contraction is 0.75 mm/d and depends on the degree of tissue laxity and shape of the wound. Loose tissues contract more than tissues with poor laxity, and square wounds tend to contract more than circular wounds. Wound contraction depends on the myofibroblast located at the periphery of the wound, its connection to components of the extracellular matrix, and myofibroblast proliferation.

Radiation and drugs, which inhibit cell division, have been noted to delay wound contraction. Contraction does not seem to depend on collagen synthesis. Although the role of the peripheral nervous system in wound healing is not well delineated, recent studies have suggested that sympathetic innervation may affect wound contraction and epithelialization through unknown mechanisms.

Contraction must be distinguished from contracture, a pathologic process of excessive contraction that limits motion of the underlying tissues and is typically caused by the application of excessive stress to the wound.

Maturation Phase

Collagen:

Collagen remodeling during the maturation phase depends on continued collagen synthesis in the presence of collagen destruction. Collagenases and matrix metalloproteinases in the wound assist removal of excess collagen while synthesis of new collagen persists. Tissue inhibitors of metalloproteinases limit these collagenolytic enzymes, so that a balance exists between formation of new collagen and removal of old collagen.

During remodeling, collagen becomes increasingly organized. Fibronectin gradually disappears, and hyaluronic acid and glycosaminoglycans are replaced by proteoglycans. Type III collagen is replaced by type I collagen. Water is resorbed from the scar. These events allow collagen fibers to lie closer together, facilitating collagen cross-linking and ultimately decreasing scar thickness. Intramolecular and intermolecular collagen cross-links result in increased wound bursting strength. Remodeling begins approximately 21 days after injury, when the net collagen content of the wound is stable. Remodeling may continue indefinitely.

The tensile strength of a wound is a measurement of its load capacity per unit area. The bursting strength of a wound is the force required to break a wound regardless of its dimension. Bursting strength varies with skin thickness. Peak tensile strength of a wound occurs approximately 60 days after injury. A healed wound only reaches approximately 80% of the tensile strength of unwounded skin.

Cytokines:

Cytokines have emerged as important mediators of wound healing events. By definition, a cytokine is a protein mediator, released from various cell sources, which binds to cell surface receptors to stimulate a cell response. Cytokines can reach their target cell by endocrine, paracrine, autocrine, or intracrine routes. Some important cytokines are described as follows:

- Epidermal growth factor was the first cytokine described and is a potent mitogen for epithelial cells, endothelial cells, and fibroblasts. Epidermal growth factor stimulates fibronectin synthesis, angiogenesis, fibroplasia, and collagenase activity.
- Fibroblast growth factor is a mitogen for mesenchymal cells and an important stimulus for angiogenesis. Fibroblast growth factor is a mitogen

for endothelial cells, fibroblasts, keratinocytes, and myoblasts. This factor also stimulates wound contraction and epithelialization and production of collagen, fibronectin, and proteoglycans.

- PDGF is released from the alpha granules of platelets and is responsible for the stimulation of neutrophils and macrophages and for the production of transforming growth factor-β. PDGF is a mitogen and chemotactic agent for fibroblasts and smooth muscle cells and stimulates angiogenesis, collagen synthesis, and collagenase. Vascular endothelial growth factor is similar to PDGF but does not bind the same receptors. Vascular endothelial growth factor is mitogenic for endothelial cells and plays an important role in angiogenesis.
- Transforming growth factor-β is released from the alpha granules of platelets and has been shown to regulate its own production in an autocrine manner. This factor is an important stimulant for fibroblast proliferation and the production of proteoglycans, collagen, and fibrin. The factor also promotes accumulation of the extracellular matrix and fibrosis. Transforming growth factor-β has been demonstrated to reduce scarring and to reverse the inhibition of wound healing by glucocorticoids.
- Tumor necrosis factor-α is produced by macrophages and stimulates angiogenesis and the synthesis of collagen and collagenase. Tumor necrosis factor-α is a mitogen for fibroblasts.

Classification of surgical wounds according to Risk of infection

Type	Definition
Clean	Non traumatic No break in technique Respiratory, alimentary or genitourinary tract not entered
Clean contaminated	Gastrointestinal or respiratory tract entered, without significant spillage. Oropharynx, vagina or non-infected genitourinary or biliary tract entered. Minor break in technique
Contaminated	Major break in technique Traumatic wound Gross spillage from gastro intestinal tract Entrance into genitourinary or biliary tracts in presence of infected urine or bile
Dirty	Presence of pus or perforation, or incision through an abscess.

Care of wound in its simplest form and based on the contemporary knowledge, evolved along with the evolution of mankind. From that time tell date, enormous innovative measures and techniques in the management and closure of wounds have evolved. The recorded history of wound closure is as old as that of medicine. The Edwin Smith Surgical Papyrus which was written in Egypt during the seventh century B C, was apparently a historical document when it was written, because it contained material dating back to 2500 to 3000 BC. This document is the first to mention surgical suturing in the passage interpreted, “Thou shoudst draw together for him his gash with stiching”. Wound closure techniques have evolved a great deal from the earliest development of suturing materials. These evolutions have provided us variety of suture materials, absorbable ones, staples, tapes and adhesive compounds.

WOUND MANAGEMENT

The technique of suturing is thousands of years old. The history of wound suturing reflects that of surgery itself. Wound treatment includes the technique of suturing as well as suturing materials. Of the above mentioned two, wound suturing plays a prominent role. Though the technique of suturing to close the dead space, to support and strengthen wounds until healing increases the tensile strength, to approximate skin edges for an aesthetically pleasing and functional result, and to minimize the risks of bleeding and infection, have remained the same.

The history of sutures begins more than 2000 years ago with the first records of eyed needles. The Indian plastic surgeon, Susruta (AD 380-450), described suture material made from flax, hemp and hair12. At that time, the jaws of the black ant were used as surgical clips in bowel surgery. In 30 AD, the Roman census again described the use of sutures and clips. In 150 AD Galen described the use of silk and catgut. Before the end of the first millennium, Avicenna described monofilament, with his use of pig bristles infected wounds. Surgical and suture technique evolved in the late 1800s with the development of sterilization procedures. The first synthetics were developed in the 1950s and further advancements have led to the creation of various forms. The different types of sutures offer different qualities in terms of handling, knot security, and strength for different purposes. A new technology that is available for wound closure is surgical adhesive.

OCTYLCYANOACRYLATE

Cyanoacrylate provides patients the option of suture less skin closure and its use is fast catching up. Presently 2 octylcyanoacrylate, a longer chain polymer which gives a stronger bond is in use. Several other compounds from the same family of cyanoacrylates have been developed, such as methylcyanoacylate, ethycyanoacrylate, isobutylcyanoacrelate, and butylcyanoacrylate13. Histotoxicity responsible for the degree of inflammatory response, is related to the chain length of these compounds, the last generation of these adhesives is Octylcyanoacrylate, which results in less heat when applied, lower inflammatory reaction and relatively higher tensile strength than the previous compounds. The polymer 2 octyl cyanoacrylate was formulated to correct some of the deficiencies of the shorter chain cyanoacrylate derivatives. As an 8 carbon alkyl derivative, this polymer should be less reactive than the shorter chain derivative. The slower degradation of the octyl derivatives may result in lower concentration of the cyanoacrylate polymer by-products in surrounding tissues resulting in less inflammation. The Cyanoacrylates are safe for clinical use with no reports of adverse effects or carcinogenicity.

The Cyanoacrylates were first synthesized in 1949 by Airdis and since then they have been applied for medical use Coove et al described their adhesive properties and suggested their possible use for surgical adhesives. In the early 1960s, various surgical applications were investigated for these adhesives. Cyanoacrylates can be synthesized by reacting formaldehyde with alkyl Cyanoacetate to obtain a prepolymer which by heating, is depolymerized into a liquid monomer. This monomer can then be modified by altering the alkoxycarbonyl (-CooR) group of the molecule to obtain compounds of different chain lengths. Upon application to living tissues (water or base), the monomer undergoes an exothermic hydroxylation reaction that results in polymerization of the adhesive. The shorter chain derivatives. Cyanoacrylates may be very simplistically defined as solvent free, synthetic adhesives. They are reactive monomer liquids that polymerize into a film when initiated by moisture or certain chemicals. A key property of cyanoacrylates is that the monomer liquid actually polymerizes directly on the surface where it is applied, creating a high quality and very tenacious polymer film. Cyanoacrylates typically fix within a minute and achieve full bond strength in 24 hours.

The first Cyanoacrylate glues comprised short chain molecules with low breaking strength and a brittle consistency which left them prone to fracturing. Their use was restricted to low tension wounds where little tensile strength was required in the closure material and invitro studies demonstrated to low tensile wound strength compared to monofilament sutures. Recently longer chain cyanoacrylates have been introduced with improved tensile strength and more powerful adhesion of wound edges. Additionally plasticizers are added to these longer chain cyanoacrylates to produce more pliable and tissue compatible product that flexes with the skin and remains inherent for longer periods of time. The 3 dimensional wound breaking strength of 2 octyl cyanoacrylates is 4 times that of n-2 butylcyanoacrylate. This stronger flexible bond may allow its use on longer incisions. Animal studies suggest its tensile strength to be superior to adhesive tape strips, equivalent to subcuticular suturing but inferior to skin staples and its use in higher tension wounds is not recommended. This was reinforced clinically by Bernard et.al., who demonstrated an improved cosmetic outcome where suturing was used to close wounds involving tissue excision resulting in higher wound tension. Since its first use in 1996, the topical tissue adhesive 2 octyl cyanoacrylate has become a popular method for closing skin lesions, such as laparoscopic incisions and trauma induced lacerations, in areas of low tension.

Although cyanoacrylates are licensed for external use but many studies report their use in various internal situations such as the repair of bronchopleural fistulae, myocardial tears, mesh fixation for inguinal hernia and adhesion of bone or cartilage. 2 Octyl cyanoacrylate adhesive polymerizes through on exothermic reaction in which a small amount of heat is released. With the proper technique of applying adhesive in multiple thin layers (atleast three) onto a dry wound and allowing time for polymerization between application, heat is released slowly and the sensation of heat or pain experienced by the patient is minimized. If adhesive is applied so that large droplets of liquid are allowed to remain unspread, the patient may experience a sensation of heat or discomfort. Extra caution should be taken to avoid depositing any adhesive in the wound; the adhesive will not seep into the wound since it starts to polymerize instantaneously. A common mistake is to inadvertently deposit the adhesive in the wound by pushing the tip of the vial into the wound and separating the wound edges.

Traditionally, needle skin suturing with suture material is used because of its cost effectiveness. In traditional skin closure with suture material, patients experience more pain during postoperative period, patients cannot have a shower and patients have to come for suture removal. Even after healing, there will be track marks of suture. Chances of wound infection are higher with needle skin suturing than with closure using adhesive glue. The risk of getting blood borne viral infections like HIV, HBV etcetera, however small it is, always exists with needle skin closure. On the other hand 2 octylcyanoacrylate is easier to use and provides a flexible, water resistant, sealed skin closure, 2 octylcyanoacrylate gives a cosmetically better outcome than with needle skin suturing. 2 octylcyanoacrylate provides a needle free method of wound closure, an important consideration because of blood borne viruses (eg. HIV). It requires no bandaging due to its antimicrobial properties. Advantages with the use of glue are: gives less pain during the postoperative period, patients can have a shower, needs no suture or staple removal, disappears naturally as incision heals without leaving mark.

The engineering of sutures in synthetic material along with standardization of traditional materials (eg, catgut, silk) has made for superior aesthetic results. Similarly the creation of natural glues, surgical staples and tapes to substitute for sutures has supplemented the armamentarium of wound closure techniques. Aesthetic closure is based on knowledge of healing mechanisms. Choosing the proper material and wound closure technique ensures optimal healing. 2 octyl cyanoacrylate is the latest skin adhesive glue, used for faster skin closure. So it is essential to do a comparative study of the two techniques of skin closure.

MECHANISMS OF WOUND HEALING

Dermal wounds heal by 3 main mechanisms: connective tissue deposition, contraction and epithelialisation. Depending on the type of wound, these 3 distinct processes come into play to varying degrees. For example, an acute linear wound, such as a surgical incision that is closed by the surgeon using sutures, staples, tapes, or perhaps dermal glue, heals by what is termed primary intention. The major mechanism needed to heal wounds by primary intention is the process of connective tissue deposition. No contraction is needed because the surgeon has closed the incision by mechanical means. There is only minimal epithelization, which occurs along the wound line on the surface.

Open wounds, in which there is a loss of tissue, such as seen when a fingertip is injured, heal by a process termed secondary intention. These open wounds heal mainly by tissue contraction in which a centripetal force is generated by an interaction between fibroblasts and the matrix to advance the edges toward the center of the wound. There may be some matrix deposition, and what is not achieved by those 2 processes is then covered by epithelization. Some chronic wounds, such as pressure ulcers, also heal by secondary intention once the chronic inflammation is controlled and granulation tissue is allowed to form. If an open wound is suspected to be contaminated with foreign debris or bacteria, then the wound must be kept open and treated with gentle irrigation until the foreign materials and infectious agents are removed.

As a general guide, the total bacterial burden should be lower than 105 organisms/g of tissue, as determined by biopsy and culturing. Surface swabs are generally thought to be inaccurate. The wound should be gently irrigated with saline or lactated Ringer, and pressures greater than 15 psi should be avoided because they can force materials deeper into the wound bed and also damage newly farming granulation tissue. Once these goals are achieved and if the wound can be closed, then the wound heals by a mechanism termed delayed primary intention.

Epithelialization is the process whereby epithelial cells surrounding the wound margin or in residual skin appendages, such as Rete pegs, hair follicles, and sebaceous glands, migrate into the wound because of the loss of contact inhibition of cuboidal basal keratinocyts . This type of healing is termed partial thickness healing and is observed in minor abrasions and skin graft donor sites when an approximately 0.015 inch thick piece of skin is removed for coverage elsewhere on the patient. After an extensive multistep process, these basal epithelial cells proliferate near the wound margin, producing a monolayer that moves over the wound surface.

Normal and Pathologic responses to wound healing

Acute wounds progress through the phases in an orderly fashion for normal healing to occur. Chronic wounds begin the healing process in a similar fashion; however, they have prolonged inflammatory phase in which there is significant destruction of the matrix elements caused by the release of proteolytic enzymes from the neutrophils. Once the excessive inflammation is controlled by aggressive wound care, then the proliferative and remodelling phases begin; however, the resulting scar is often excessive and fibrotic. These chronic non healing ulcers are examples of severely deficient healing. Despite extensive research into the mechanisms underlying wound healing, patients continue to be plagued by such pathologic conditions of abnormal wound healing in other tissues and organs, including recurrent and incisional hernias, anastomotic leaks, and wound dehiscence.

In conditions of fibrosis, the equilibrium between scar deposition and remodelling is such that an excessive amount of collagen deposition and organization occurs. This condition leads to a loss of both structure and function. Fibrosis, strictures, adhesion, keloids, hypertrophic scars, and contractures are the outcome of excessive pathologic healing. Clinical differences between chronic and acute healing wounds are thought to be, in part, explained by alterations in the local biochemical environment. Acute wounds are associate with a greater mitogenic activity than chronic wounds.

Chronic wounds are associated with a higher level of proinflammatory cytokines than acute wounds. Elevated protease activities in some chronic wounds may directly contribute to poor healing by degrading proteins necessary for normal wound healing, such as extra cellular matrix proteins, growth factors, and protease inhibitors. Steed and colleagues reported that extensive debridement of diabetic ulcers resulted in improved healing in patients treated with placebo or with recombinant human PDGF. Frequent debridement may therefore allow a chronic wound to heal in a similar fashion to an acute wound. In addition to the local wound environment, there are dates to suggest that cells of chronic wounds may have on altered capacity by which to respond to various cytokines and growth factors and are in a senescent state.

TYPES OF SUTURE MATERIALS:

Sutures can be divided into two categories, depending on whether they are composed of natural fibres or synthetic materials. Although natural fibre sutures have been used traditionally and have been largely effective for most surgical situation, the recently developed synthetics may be desirable for, among other reasons, reducing chronic tissue reactivity to foreign organic material. This is particularly important when choosing an absorbable suture because, when using catgut, one must contend not only with an initial inflammatory reaction comparable to that of other sutures but also with a renewal of tissue reactivity when the catgut begins to be broken down and absorbed by the tissue. The choice of absorbable and nonabsorbable suture materials further divides the range of sutures available. The decision of whether to use absorbable or non absorbable sutures depends upon a number of factors, including the rate at which the wounded tissue is likely to heal, the amount of stress and strain to which the wound site will be subjected over the course of healing, the potential for growth of the wound, and the question of whether the sutures need to be only temporary aids to healing or a means of permanent mechanical support. Sutures are further classified as either monofilament or multifilament. Multifilament sutures can be either twisted or braided. In general monofilament sutures are advantageous because the multiple strands of multifilament sutures provide an environment for potential infection. Multifilament sutures, particularly in their braided form, also tend to be more vulnerable to shearing forces and thus are more susceptible to breakage. Monofilament sutures, although less susceptible to shear, can be damaged and weakened by the crimp of the forceps or other instruments and thus require careful surgical handling. The different types of sutures currently available are listed and classified as in the table.

Characteristics of some of the commonly used suture materials

Properties	Silk	Nylon Monofilament	Nylon Multi Filament	Poly Propylene	Adhesive Glue
Handling	Excellent	Poor	Fair-Good	Poor	Excellent
Knot Security	Excellent	Poor	Fair-Good	Poor	-
Memory	Low	High	Medium	High	-
Tissue Reactivity	High	Low	Medium	Low	Low

Silk

Silk was first widely used as a suture material in the 1890s. It is a braided material formed from the protein fibres produced by silkworm larvae. Although silk is considered a non-absorbable material, it is gradually degraded in tissue over 2 years. Silk has excellent handling and knot tying properties and is the standard to which all other suture materials are compared. Its knot security is high, tensile strength low, and tissue reactivity high. Suture removal can be difficult and painful because the braided material becomes infiltrated with cells and encrusted with debris while the sutures are implanted in the skin.

Nylon:

Introduced in 1940, nylon was the first synthetic suture available, and it is the most commonly used non absorbable material in dermatologic surgery. It is available in both monofilamentous and multifilamentous forms. Nylon has a high tensile strength and, although it is classified as non-absorbable, it loses tensile strength when buried in tissue. Multifilamentous forms retain no tensile strength after being in tissue for 6 months, whereas monofilamentous forms retain as much as two thirds of their original strength after 11 years. Monofilament nylon is stiff, therefore, handling and tying are difficult and knot security is low. The suture also may cut easily through thin tissue. Multifilamentous forms have better handling properties but greater tissue reactivity. Monofilament nylon is relatively inexpensive and available as black, green, or clear. Although its greatest use is as a percutaneous suture, because of its low tissue reactivity, nylon (clear) can be used as a buried suture in situations in which prolonged dermal support is necessary.

Polypropylene:

Polypropylene (Prolene; Ethicon) is a monofilament synthetic surure that was introduced in 1962. Its tensile strength is lower than that of the other synthetic nonabsorbable sutures. Its handling, tying and knot security are poor as a result of its stiff nature and high memory. An additional throw is needed for adequate knot security. A method to improve security is the use of thermocautery to fuse the knots or transform the ends into small beads. Tissue reactivity is extremely low for polypropylene, and unlike nylon, gradual absorption does not occur if it is buried in tissue. As result, polypropylene is an excellent choice for a buried suture for long term dermal support. It is a plastic suture that accommodates tissue swelling, therefore the likelihood of it cutting through the tissue and causing crosshatching is less than that of other materials, easily slides through tissue; this characteristic makes it the suture of choice for a running subcuticular closure.

Glues and Adhesives:

Tissue adhesives (products made from synthetic material) and glues (products made from naturally occurring material) in surgical practice fall into 3 categories:

1. <u>Biological natural compound</u> like fibrin, gelatin based, those of fibrin based glues function by reproducing the latter stage of normal clotting cascade leading to the formation of stable fibrin clot. These glues are used largely as haemostatic agents for bleeding surface and vascular Anastomosis. There is a wide range of fibrin product variety but in essence they fall into 2 types, two component fibrin and croprecipitate based glues, the composition of the two component type is basically the same, despite several different product proprietary names, the many

different preparation vary in the source of the fibrinogen (usually human), the thrombin (usually bovine).

1) Gelatin based glues:

These provide alternative resorbable biological glues that have greater bonding strength than fibrin based glue, GRFG (gelatin, resorcinol, formaldehyde & gluataradehyde) was the first generation. The second generations of gelatin hydrogel glues are much less toxic as the formaldehyde has been substituted with other cross linking agents. Fibrin adhesives can be created from autologous sources of pooled blood. They are typically used for haemostasis and can seal tissue while they do not have adequate tensile strength to close skin. Commercial preparation such as tisseel and hemaseel are Food and Drug Administration (FDA) approved. Gelatin based glues are photochemically activated surgical tissue 'bonding for soldering' technology involves using photo reactive gelatins and a water soluble dysfunctional macromer polyethylene glycol diacrylate (PEGDA). Photoreactive groups, for example, fluorescein sodium salt, eosin Y, and rose bengal are incorporated in the gelatins, which are then suspended in a saline solution containing PEGDA forming a viscous. This forms an adhesive hydrogel within 1 minute when irradiated with the appropriate light. The resulting gel is tightly adherent to soft tissues such as the liver. Experimentally this photo curative gelatin glue has been used to seal effectively arteriotomies in canine abdominal or thoracic aortas. This glue has great potential application in laparoscopic surgery, as the percutaneous delivery of the glue followed by in situ photogelation will result in prompt, safe and effective haemostasis [Nakaymama et al 1999].

2) Adhesive based on protein engineering:

These polymers are still at the experimental stage, but show great promise as bio compatible and biodegradable internal sealants, they are based on proprietary protein engineering based on DNA gene technology, epithalization and healing with absorption of the material were observed at 28 days, and the wound strength was equivalent to sutured controls.

3) Synthetic glues (Cyanoacrylates):

Since 1949 skin adhesives have been applied for medical use. Cyanoacrylate, the first adhesive used for skin closure, polymerizes in contact with human tissues. Polymerization is an exothermic chemical reaction that generates heat. Depending on the intensity of this reaction, it may cause pain when applied to the skin. Several other compounds from the same family of cyanoacrylate have been developed, such as methyl-cyanoacrylate, ethyl-cyanoacrylate, isobuty1- cyanoacrylate, and butylcyanoarcylate. Histotoxicity responsible for the degree of inflammatory response, is related to the chain length of these compounds. The last generation of these adhesives is octylcyanoacrylate, which results in less heat when applied, lower inflammatory reaction, and relatively higher tensile strength than the previous compounds. The cyanoacrylates are safe for clinical use with no reports of adverse effects or carcinogenicity. The first cyanoacrylate glues comprised short-chain molecules with low breaking strength and a brittle consistency which left them prone to fracturing. Their use was restricted to low tension wounds where little tensile strength was required in the closure material and in vitro studies demonstrated a low wound tensile strength compared to monofilament sutures. Recently longer chain cyanoacrylates have been introduced with improved tensile strength and more powerful adhesion of wound edges. The longer chain cyanoacrylate is a combination of monomers and plasticizers. Its 3 dimensional wound breaking. Strength is 4 times that of n-2-butylcyanoacryalte. Animal studies suggest its tensile strength to be superior to adhesive tape strips, equivalent to subcuticular suturing but inferior to skin staples, and its use in higher tension wounds is not recommended. Since its first use in 1996, the topical tissue adhesive has become a popular method for closing skin lesion, such as laparoscopic incisions and trauma induced lacerations, in areas of low tension.

Although cyanoacrylates are only licensed for external use, many studies report their use in various internal situations such as the repair of bronchopleural fistula, myocardial tears, mesh fixation for inguinal hernia and adhesions of bone or cartilage. In 1986 Shendra et.al., reported that bleeding from gastric varices could be controlled by sclerotherapy using the tissue adhesive agent butylcyanoacrylate. Contaminated lacerations closed with suture materials are at increased risk of wound sepsis due to local tissue damage and the adsorption of pyogenic bacteria by suture material. Further one study suggests that combination of n- butyl-2 cyanoacrylate and a blue may be bacteriostatic for pyogenic gram – positive cocci. In contrast, Olson et al. found that S.epidermidis rapidly colonizes n-butyl-2 cyanoacrylate, producing a bio film of embedded bacteria. Cyanoacrylate is applied in a thin layer over the entire wound and extending 5-10 millimetre beyond the wound edge. The formation of the bond produces heat that the patient can feel. Once the layer is dried (10-30 seconds), a second layer is applied. Three to four layers are necessary. No additional bandaging is required, and the patient is advised to not perform wound care at home. By 7-14 days, most of the adhesive sloughs with the epidermis, and the remainder may be removed with soap and water or petroleum jelly.

Contra indications to use of skin Adhesives
Jagged or satellite lacerations
Bites, punctures or crush wounds
Contaminated wounds
Mucosal surfaces
Axillae and perineum (high moisture areas)
Hands, feet and joints (unless kept dry and immobilized)

Truseal is quick and easy to apply, only one tenth to one fourth of the time required for suture placement is needed. It provides an antimicrobial and water proof coating, but repeated washing removes the adhesive in a few days. The cosmetic outcome generally is good, and no postoperative visit is required for its removal.

Advantages of Adhesive Vs Sutures
Maximum bonding strength at two and one half minutes
Equivalent in strength to healed tissue at 7 days post repair
Can be applied using only a topical anaesthetic, no needles
Faster repair time
Better acceptance by patients
Water resistant covering
Does not require removal of sutures

The clinical usage of tissue glue (octyl‑cyanoacrylate adhesives) has been extensively studied for diverse applications including tissue adhesion, wound closure, hemostasis, closure of cerebrospinal fluid (CSF) leaks, vascular embolization and application of skin grafts.

Developed in 1949, the cyanoacrylate adhesives are applied topically to the outermost skin layer as monomers in a liquid form. On contact with tissue anions, they polymerize forming a strong bond that holds the apposed wound edges together. The cyanoacrylate adhesives usually slough off with wound re‑epithelialization within 5‑10 days and do not require removal.[6]

Therefore a lot of studies are conducted using OCA for wound closure, especially in the region where cosmesis is required.

MATERIALS AND METHODS

Aim of the study:

To study the efficacy of Cyanoacrylate glue in comparison to routinely used subcuticular sutures in thyroidectomy wound closure in GRH, Madurai.

Materials Used:

1. Cyanoacrylate Glue
2. Prolene for subcuticular sutures.

Methodology:

The study is about the comparison regarding cyanoacrylate glue and subcuticular sutures in thyroidectomy wound closure. This study is carried out in Government Rajaji Hospital, Madurai for a period of 2 years from August 2016 to August 2018.

The Study consists of 50 subjects. They are divided into 2 groups. In both the groups, thyroidectomy surgeries are done in the regular manner with a horizontal skin crease incision, placed two finger breadth (2-3 cm) above the sternal notch extending from posterior border of one sternocleidomastoid to opposite side. Thyroidectomy surgery was done in a routine manner. During closure, **platysmal** sutures will be put to relieve tension, obliterate the dead space and apposition of wound edges. Then the wound will be closed by cyanoacrylate glue or subcuticular skin sutures based on preoperatively divided group.

Fig: 6 Shows closure of the platysmal ayer before application of OCA.

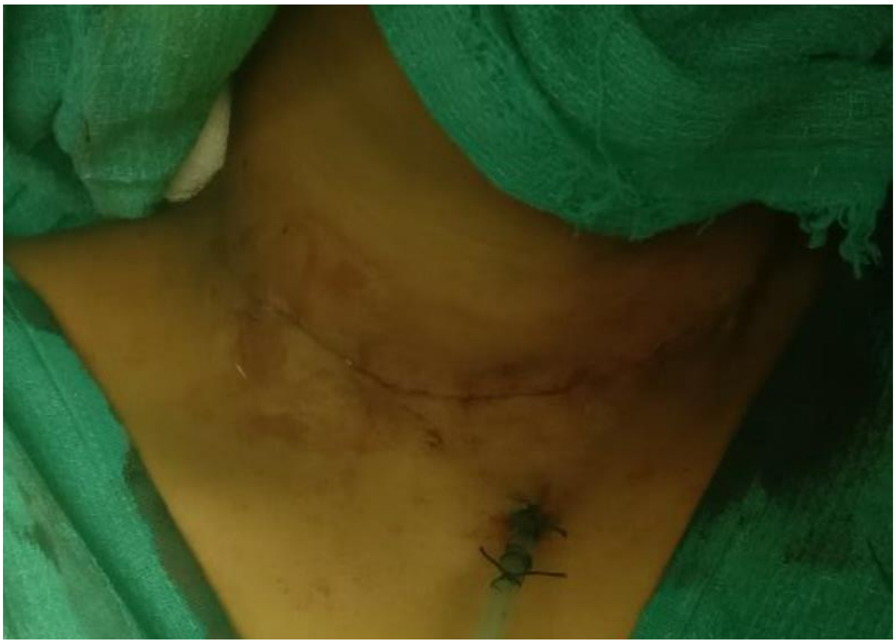


Fig: 7 Shows the appearance of wound after application of cyanoacrylate glue.

Wound will be examined on Post Op Day - 3, Post Op Day - 7 then at 1 month and 6 month interval. Wound will be evaluated for Erythema, infection, swelling, serous discharge, overlap of edges, separation of edges, wound dehiscence, hypertrophic scar with the help of **Modified Hollander Wound evaluation Scale** and **South Hampton Grading Scheme**. For Surgical Wounds. Photograph of the scar will be taken after six months of closure for evaluation for cosmetic appearance.

Fig: 8 Shows the wound appearance on POD 3 with a drain in situ. (Wound closed using sub cuticular prolene suture)

Fig: 9 Shows the wound appearance of patient with subcuticular sutures on POD 7.

Fig: 10 Shows the post op image of a patient with cyanoacrylate glue on POD 7.

Fig: 11 Shows the post op image of a patient closed with cyanoacrylate glue on POD 30 with a 1x1 cm collection that subsided on aspiration.

Fig: 12 Shows the post-operative picture of patient with cyanoacrylate glue on 6 month follow up.

Wound appearance will be determined by 4 item Modified Hollander Wound Evaluation scale. Wound will be assigned 0 or 1 point for each for the presence or absence of the following:

1- Step of borders (0 for yes, 1 for no)
2- Contour irregularities- puckering (0 for yes, 1 for no)
3- Wound margin separation (0 for yes. 1 for no)
4- Good overall appearance (0 for poor, 1 for acceptable)

Wound with a score of 4 is considered to have an optimal cosmetic appearance, others sub optimal appearance.

South Hampton grading scheme is used for the grading of surgical wounds.

South Hampton grading scheme:

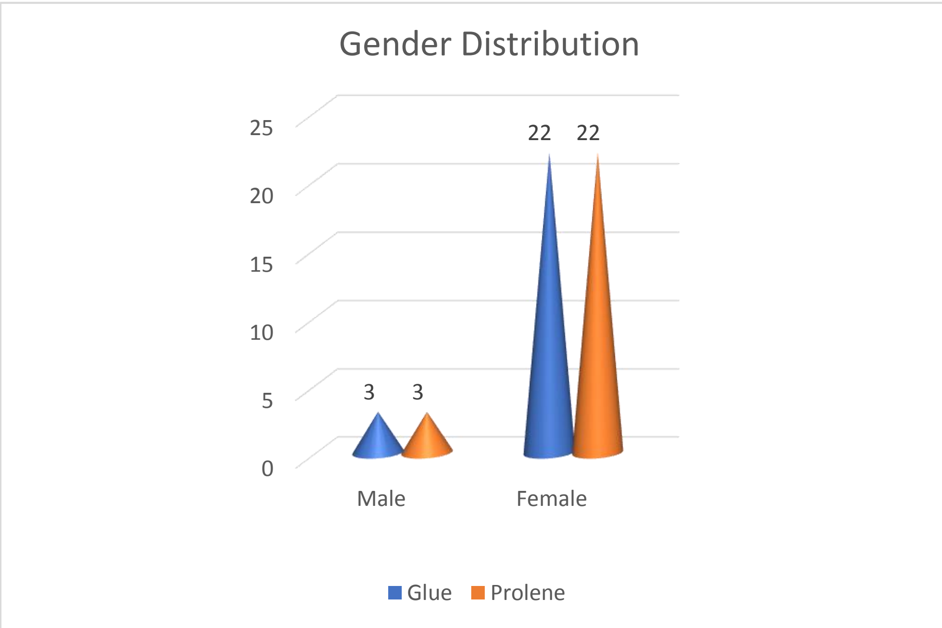
MAJOR FINDING	ADDITIONAL FINDINGS	GRADE
Normal Healing		0
Normal Healing with mild bruising or Erythema		I
	- Some bruising	Ia
	- Considerable bruising	Ib
	- Mild Erythema	Ic

Erythema plus other signs of inflammation	- At one point - Around sutures - Along wound - Around wound -	II IIa IIb IIc IId
Clear or haemoserous discharge	- At one point only (<=2cm) - Along wound (>2cm) - Large volume - Prolonged Drainage (>3 Days) -	III IIIa IIIb IIIc IIId
Pus	- At 1 point only (<=2cm) - Along wound (>2 cm) -	IV IVa IVb
Deep or Severe wound infection	With or without tissue breakdown or hematoma requiring aspiration	V

OBSERVATION AND RESULTS

GENDER DISTRIBUTION OF THE PATIENTS:

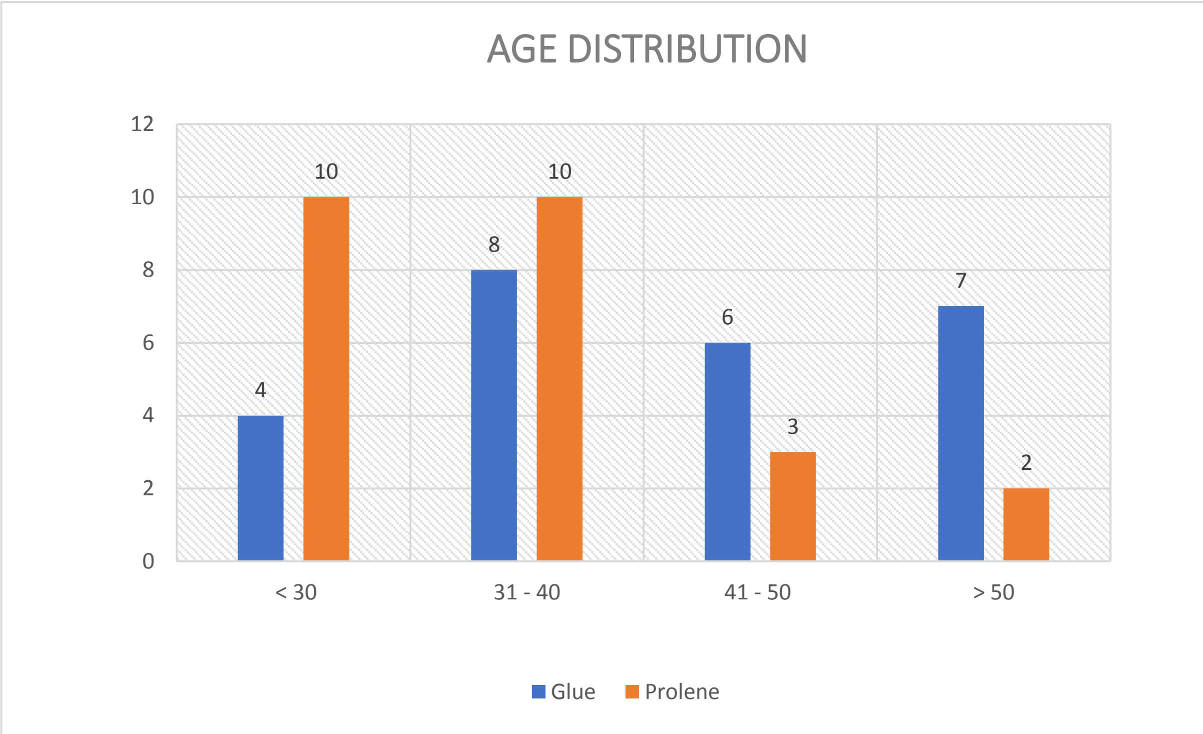
GENDER	GLUE	PROLENE
Male	3	3
Female	22	22
Total	25	25
p value	1	Not sig



A total number of 50 patients were randomly divided into 2 groups with each group containing 25 patients. Out of the 25 patients 22 were female patients and 3 were male patients. This shows that thyroid disorders are more common in females as compared to males.

AGE DISTRIBUTION OF SUBJECTS:

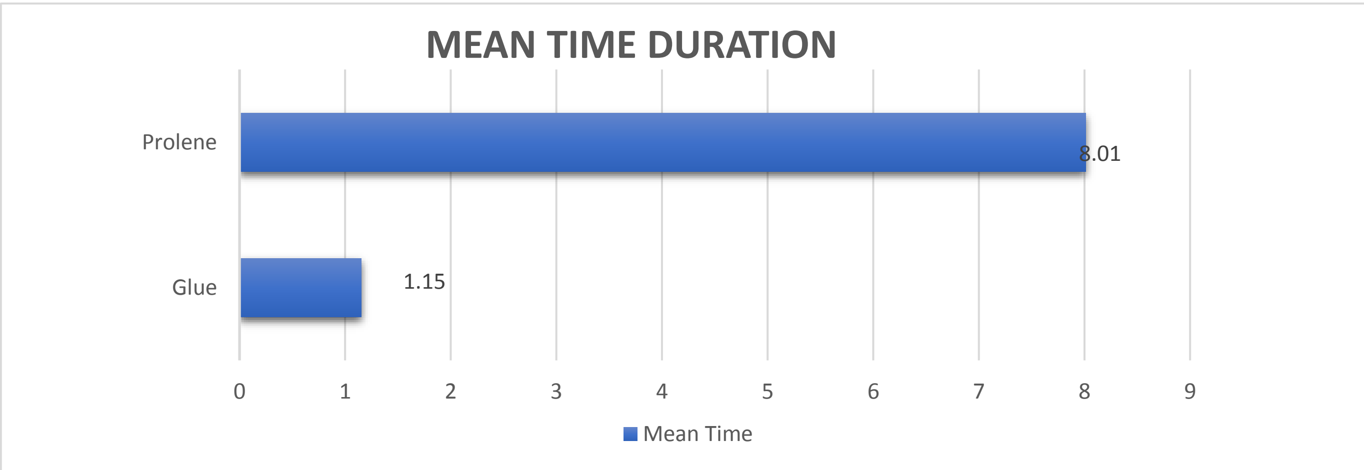
AGE(in years)	<30	31-40	41-50	>50	Total	Mean	SD	P Value
OCA	4	8	6	7	25	43	12.29	0.256
PROLENE	6	9	5	5	25	40.9	10.85	Not Significant



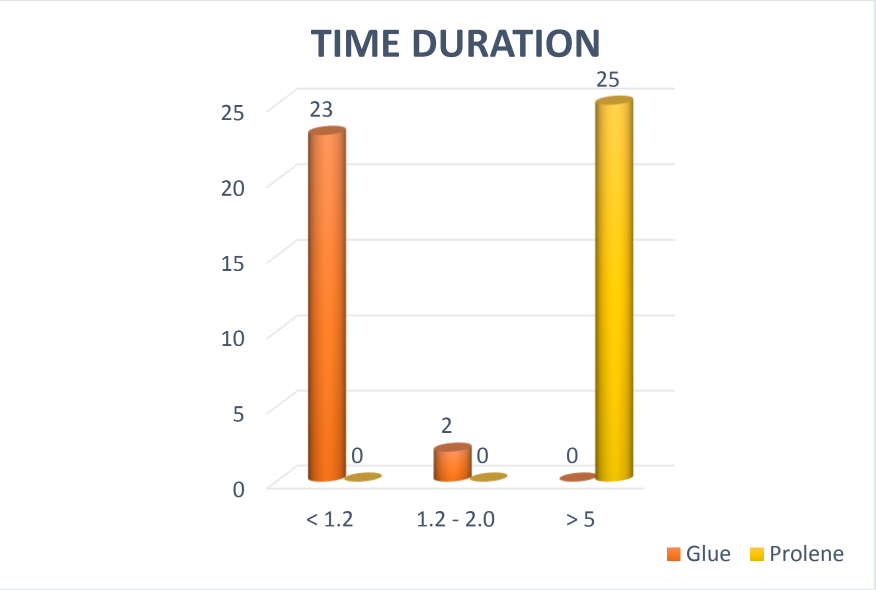
In the study undertaken, the mean age of the population in the study is 43yrs for OCA and 40.9 yrs for Sub cuticular prolene sutures. There is no statistical difference between the study subjects of both the groups, hence the study is undertaken in similar age groups.

TIME DURATION BETWEEN OCA AND SUB CUTICULAR SUTURES

TIME DURATION	<1.2	1.2 – 2.0	>5	Total	Mean	SD	P value
GLUE	23	2	0	25	1.15	0.065	<0.001
PROLENE	0	0	25	25	8.01	0.861	significant



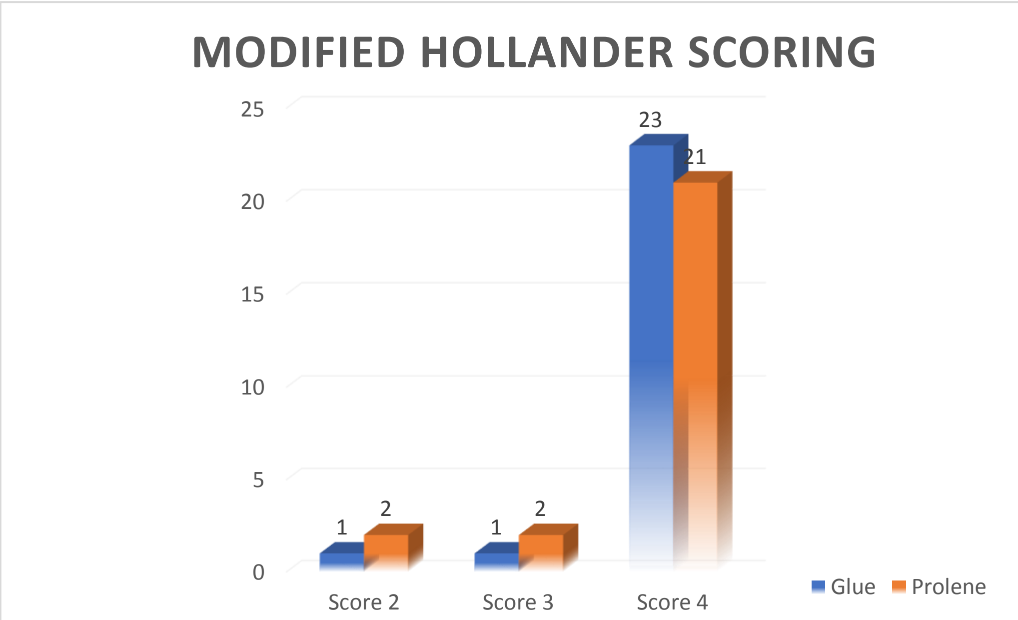
The study shows that the mean duration of time taken for OCA is 1 min 15 seconds, whereas that of subcuticular sutures is 8 minutes. This shows that the time duration taken by OCA is very less as compared to the routinely used sub cuticular prolene sutures.



23 patients out of 25 patients of OCA required less than 1 min 20 seconds whereas all the 25 patients in whom sub cuticular sutures were applied needed more than 5 minutes. As the p value is <0.001 the time duration is statistically significant.

COMPARISON BETWEEN OCA AND SUBCUTICULAR PROLENE SUTURES ON POD 3 USING MODIFIED HOLLANDER WOUND EVALUATION SCALE

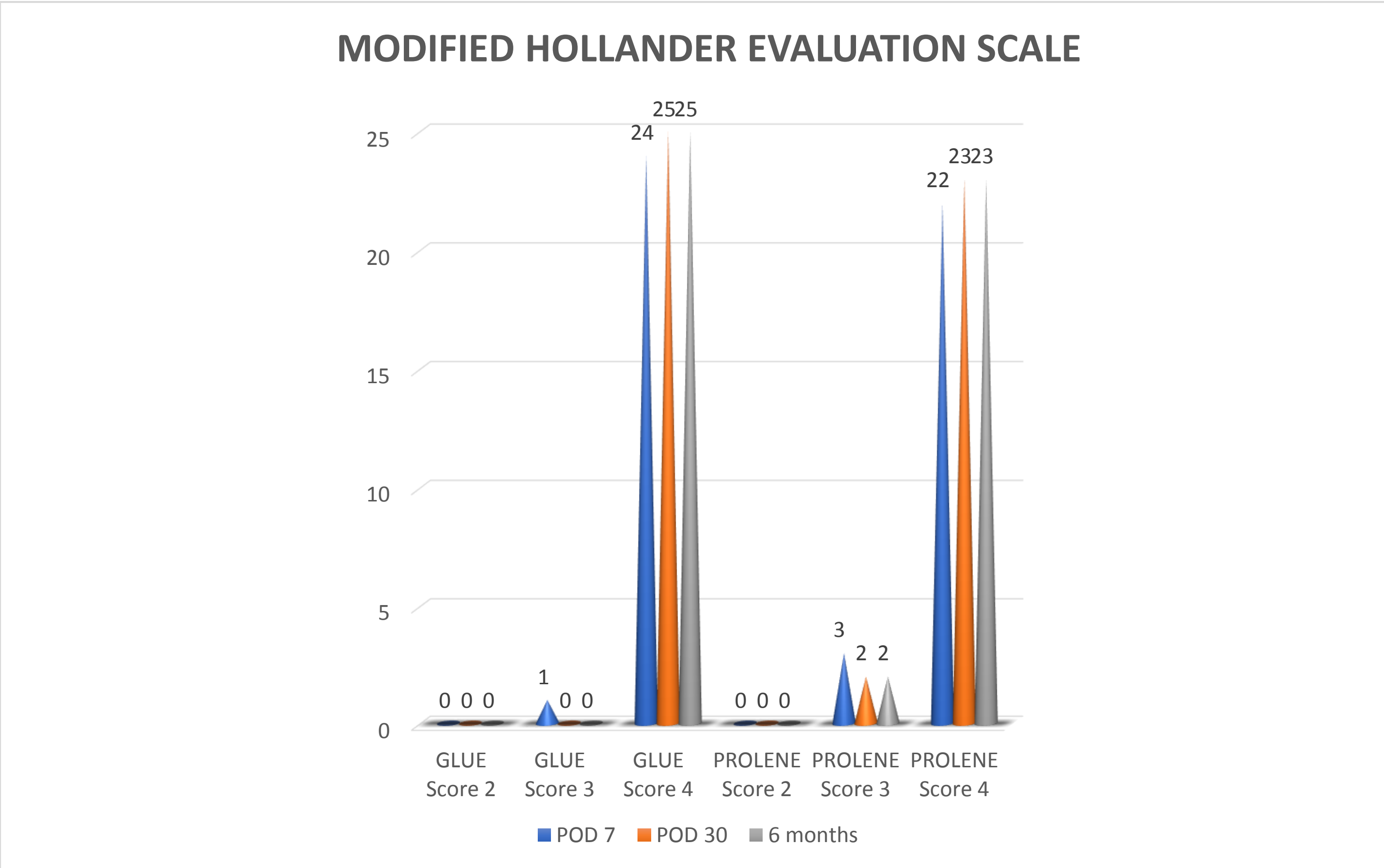
POD 3 DAY	Glue	Prolene
Score 2	1	2
Score 3	1	2
Score 4	23	21
p value	0.685	Not Significant



The study undertaken shows that 23 out of 25 patients have attained a score of 4 in OCA patients whereas 21 out of 25 patients have attained a score of 4 using modified Hollander scoring system. Though the numbers are not statistically significant the superiority of glue is noted in the total numbers.

COMPARISON BETWEEN OCA AND PROLENE SUBCUTICULAR SUTURES USING MODIFIED HOLLANDER WOUND EVALUATION SCALE ON POST OP DAYS 7, 30 AND 6 MONTHS

POD COMPARISON	GLUE			PROLENE		
	Score 2	Score 3	Score 4	Score 2	Score 3	Score 4
POD 7	0	1	24	0	3	22
POD 30	0	0	25	0	2	23
6 MONTHS	0	0	25	0	2	23

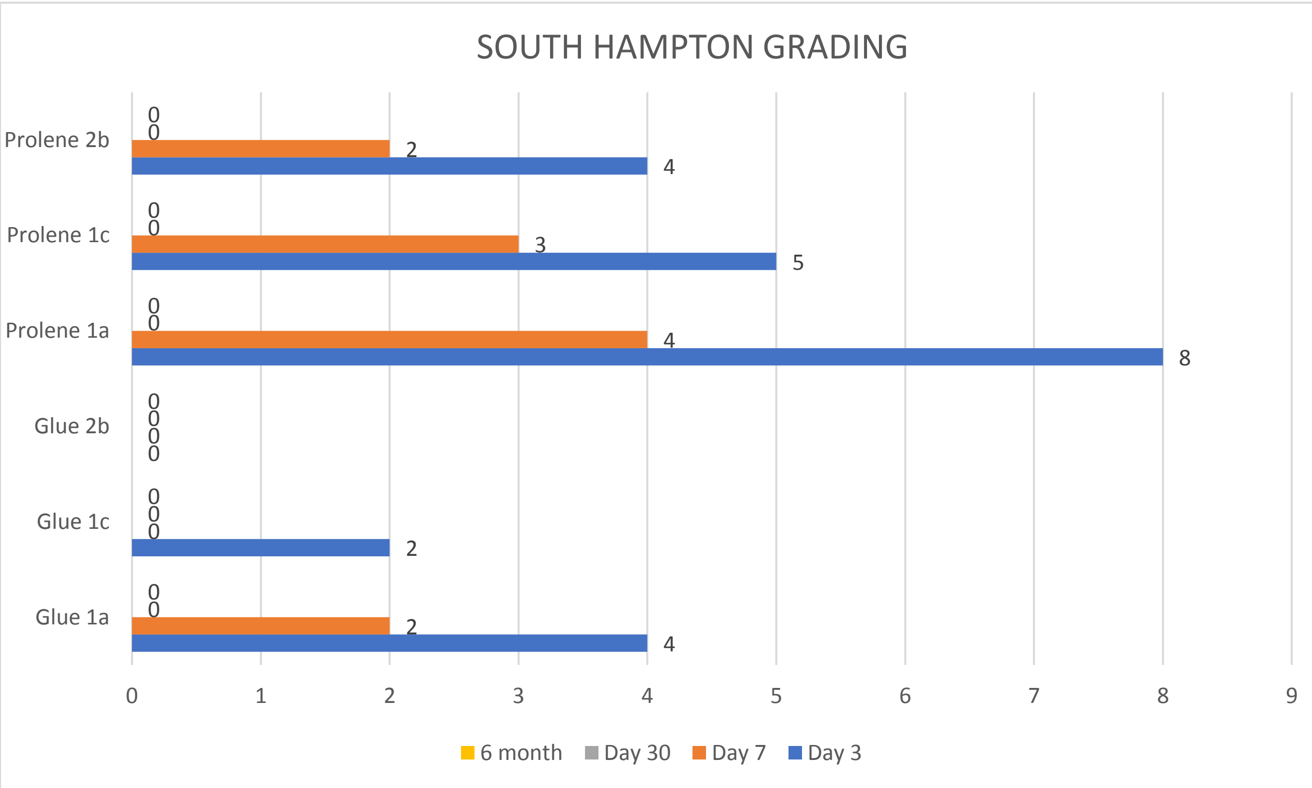


In the study conducted both OCA and prolene suture groups have attained a score more than 2. On post op day 7 only 1 patient shows a score of 3 and this patient has attained a score of 4 from post op day 30 and further. Similarly 3 patients had attained a score of 3 on post op day 7 out of which 1 patient attained a score of 4 but the rest 2 patients remained in score 3 at post op day 30 and at 6 months.

As subcuticular suturing with prolene being a skilled technique, these 2 can be due to faulty suturing techniques. On comparison the scores are not statistically significant, showing that the results of both the techniques are similar in the long term follow up.

COMPARISON BETWEEN OCA AND SUBCUTICULAR SUTURES USING SOUTH HAMPTON SCORING FOR SURGICAL SITE INFECTIONS ON POD 3, 7, 30 AND 6 MONTHS

SURGICAL SITE INFECTION GRADE	GLUE			PROLENE				
	1a	1c	2b	1a	1c	2b		
Day 3	4	2	0	8	5	4	< 0.001	Significant
Day 7	2	0	0	4	3	2	0.012	Significant
Day 30	0	0	0	0	0	0		Not sig
6 month	0	0	0	0	0	0		Not sig



In the study it was noticed that there is an increase in the total number of surgical site infections in suture group as compared to OCA. OCA group shows

4 patients belonging to grade 1a and 2 patients belonging to grade 1c, on the contrary suture group shows 8 patients belonging to grade 1a, 5 patients belonging to grade 1c and 4 patients belonging to grade 2b on post op day 3. Similarly the infection rate is high in the suture group on post op day 7. There is a higher grade of infection in prolene group as compared to the OCA group and also increased number of infections are noted in the suture group which is statistically significant on post op day 3 and 7. This shows that OCA have less inflammatory response as compared to suture group.

DISCUSSION

Thyroidectomy is a surgery commonly performed across the country, in both large volume centers and small hospitals. The incision used for thyroid surgery has become shorter overtime, from the classical 10 cm long Kocher incision to the shortest 15 mm access achieved with minimally invasive video‑assisted thyroidectomy. This is mainly to achieve a good cosmetic outcome along with less postoperative morbidity. As this surgery is well described and standardized, we based our study on this surgery to reduce inter-operative variations.

OCA have a number of advantages over conventional sutures like their fast and painless application, rapid setting, which reduces the total operating time and their antibacterial properties. OCA itself acts as a waterproof dressing and helps in reduction in the number of follow‑up visits. As they do not require any needles, accidental needle stick injuries are prevented. However, there are certain disadvantages of OCA like their less tensile strength and chances of adhesive seepage, if edges are not properly approximated.

Multiple studies have showed superior outcome with tissue adhesives as compared to skin sutures.[5‑9] however; it is important to remember that platysmal suture support is still needed and skin must be held together as the adhesive is applied to prevent the deposition of the cyanoacrylate polymer into the wound, potentially delaying or preventing the healing.[5] Bernard and coworkers in their prospective comparison of octyl cyanoacrylate tissue adhesive and suture for the closure of excisional wounds in children and adolescents found that the cosmetic outcome of cutaneous excisional surgery wounds closed with standard suturing was found to be superior to that of wounds closed with OCA;[7,9] this is supported by Handschel and coworkers in their study on facial wound closures.[10] In our study we found that there was no significant difference in the cosmetic appearances of the wound between the wounds closed with cyanoacrylate glue and sutures. David Greene and coworkers in their study found no differences in wound complications, duration of healing, inflammation, or final incision appearance between glue and suture. [11]

In our study, we did find a significant difference between the two techniques in the initial POD 3 and POD 7. Wound was cosmetically better and signs of inflammation was less in wounds closed with cyanoacrylate glue in comparison to subcuticular sutures. Scar appearance was marginally better in patients in whom OCA was used in the initial post op days. One of our patients had wound collection, in whom OCA was used, which subsided on aspiration, and this could have been due to faulty technique. [12, 13]

None of the wounds got infected thus, rendering the use of tissue glue quite safe. Quinn and co associate, in their study showed that contaminated wounds closed with sutures had higher infection rates compared with those repaired with topical tissue adhesive. [14]

Cost of OCA has been commonly mentioned as a factor. Studies have shown that simple wounds closed by tissue adhesives incur a higher cost but may be preferred by the patients, who show apprehension towards conventional suturing and who are not willing for follow-up for suture removal.[9]

But in the study conducted showed that there was not much of difference between OCA and subcuticular sutures. Along with that there is a significant difference between the duration of application of OCA and subcuticular prolene sutures. Hence prolonging the duration of anesthesia, procedure and theatre time. This additional time can be reduced, thereby saving the cost to the patient.

CONCLUSION

OCA is one of the novel techniques and efficient techniques available for wound closure especially where cosmesis is required. OCA has a better outcome than the sutures in the initial post op days but shows an equivalent cosmetic outcome in comparison to the routinely used sub cuticular prolene sutures in the long term 6 month follow up.

The cost of OCA being equivalent to prolene, OCA will not change the cost effectiveness of the procedure. Also OCA having antibacterial property and water sealing property decreases the chances of surgical site infections.

In a developing country like India, where cost and resources play a major role, it is better to use OCA than the routinely used sub cuticular prolene sutures. Suture removal is not required and reduces the frequency of visits by the patients to the hospital. Also sub cuticular suturing being a skilled procedure needs expertise in comparison to OCA.

As the study undertaken contains a sample size of 50, high chances of sampling error are present. And surgical techniques, accuracy and duration of a procedure varies from surgeon to surgeon. So further studies in a large scale, from different institutions and a longer follow up are recommended.

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PROFORMA

Name: I. P. No:

Age: - Unit:

Sex: - D.O.A:

Occupation: - D.O.D:

Address: - D.O.Surgery:

Ph NO:

CHIEF COMPLAINTS:

1) Swelling

2) Other complaints

HISTORY OF PRESENTING ILLNESS:

- Features Of
  - Hyperthyroidism
  - Hypothyroidism
  - Euthyroid
- Other History:

PAST HISTORY

1) History of previous surgeries

2) History suggestive of Hypertension/ Diabetes/ Tuberculosis/ asthma/ Immuno -suppressive disorders.

FAMILY HISTORY

Similar illness in other family members

GENERAL PHYSICAL EXAMINATION

1. General survey
2. Body build and nourishment
3. Height
4. Weight
5. Dehydration: Mild/ Moderate/ Severe/ Nil
6. Anemia/ Jaundice/ Clubbing/ Cyanosis/ Lymphadenopathy/ Pedal oedema
7. Pulse
8. Temperature
9. Respiratory rate
10. Blood pressure

CLINICAL DIAGNOSIS:

INVESTIGATIONS

1. Blood: Hb %
2. TLC
3. DLC
4. BT

5. CT

6. ESR

7. Blood group and Rh type

8. Urine: Albumin/ Sugar/ Microscopy

9. Chest x-ray

10. HIV

11. USG Neck:

12. FNAC:

13. TSH:

14. T3:

15. T4:

FINAL DIAGNOSIS:

Surgery Done:

Intra Operative Findings:

Skin Closure Material:

Biopsy Report:

Follow Up:

	South Hampton Scoring	Post Op Pain
POD-3		
POD -7		
POD-30		
6 Months		

Modified Hollander Scoring

	Step up Of Borders	Contour Irregularities	Margin Separation	Appearance	Total score
POD-3					
POD -7					
POD-30					
6 Months					

INFERENCE:

ஆராய்ச்சி தகவல் அறிக்கை

மதுரை அரசு இராஜாஜி மருத்துவமனையில் வரும் நோயாளிக்குள் தைராய்டு அறுவை சிகிச்சை செய்து கொள்பவர்களுக்கு ஒரு ஆராய்ச்சி இங்கு நடைபெற்றுவருகிறது.நீங்களும் இந்த ஆராய்ச்சியில் பங்கேற்க விரும்பிகிறோம் உங்களை சில சிறப்பு பரிசோதைக்கு உட்படுத்தி அதன் தகவல்களை ஆராய்வோம். அதனால் தங்களது நோயின் ஆய்வரிகையோ அல்லது சிகிச்சையோ பாதிப்பு ஏற்படாது என்பதை தெரிவித்து கொள்கிறேன் முடிவுகளை வெளியிடும்போது அல்லது ஆராய்ச்சியின்போது தங்களது பெயரோ அல்லது அடையாளங்களோ வெளியிடமாட்டோம் என்பதை தெரிவித்துக்கொள்கிறோம். இந்த ஆராய்ச்சியில் பங்கேற்பது தங்களுடைய விருப்பத்தின் பேரில்தான் நடக்கும். மேலும் நீங்கள் எந்நேரமும் இந்த ஆராய்ச்சியில் இருந்து பின்வாங்கலாம் என்பதையுத் தெரிவித்துக்கொள்கிறோம். இந்த பரிசோதனையின் முடிவுகளை ஆராய்ச்சியின்போது அல்லது ஆராய்ச்சியின் முடிவின்போது தங்களுக்கு அறிவிப்போம் என்பதையும் தெரிவித்துக்கொள்கிறோம்.

ஆராய்ச்சியாளரின் கையொப்பம் பங்கேற்பாளர் கையொப்பம்

MASTER CHART

	Name		Age	Sex	Time duration
1	Pushpammal	Glue	60	F	1.1
2	Veerammal	Glue	48	F	1.12
3	Sumathy	Glue	33	F	1.17
4	Pandirani	Glue	34	F	1.12
5	Petchi	Glue	43	F	1.15
6	Pandiyammal	Glue	43	F	1.16
7	Indumathy	Glue	30	F	1.12
8	Karthik	Glue	27	M	1.17
9	Subbulakshmi	Glue	59	F	1.19
10	Rajalakshmi	Glue	60	F	1.18
11	Anushya	Glue	32	F	1.05
12	Murugayammal	Glue	60	F	1.09
13	Meenakshi	Glue	56	F	1.18
14	Kaliyammal	Glue	70	F	1.15
15	Balasubramanian	Glue	37	M	1.12
16	Thangapandiyammal	Glue	45	F	1.15
17	Palaniyammal	Glue	36	F	1.08
18	Saroja	Glue	32	F	1.12
19	Meenatchi	Glue	36	F	1.15
20	Sulochana	Glue	52	F	1.18
21	Savitha	Glue	28	F	1.17
22	Vasanth	Glue	27	M	1.13
23	Mahalakshmi	Glue	43	F	1.11
24	Uma shanti	Glue	38	F	1.32
25	Jayalatha	Glue	46	F	1.35
26	Veena	Prolene	29	F	7.36
27	Jayalakshmi	Prolene	35	F	9.52
28	Pushpammal	Prolene	42	F	7.55
29	Vishalini	Prolene	23	F	8.45
30	Rachana	Prolene	38	F	9.45
31	Ramalakshmi	Prolene	20	F	7.35
32	Sheela	Prolene	28	F	7.32
33	Sasikala	Prolene	55	F	8.33
34	Poomayil	Prolene	30	F	8.15
35	Kaveriyammal	Prolene	40	F	9.12
36	Yogeshwaran	Prolene	30	M	8.43
37	Kamatchi	Prolene	36	F	7.54
38	Nirmala	Prolene	42	F	8.35
39	Divya	Prolene	28	F	8.44

40	Suganya	Prolene	30	F	9.08
41	TamilSelvi	Prolene	39	F	7.53
42	Muttumari	Prolene	32	F	9.18
43	Lingammal	Prolene	55	F	7.45
44	Velmurugan	Prolene	26	M	8.33
45	Poomayil	Prolene	34	F	8.54
46	Ester Julie	Prolene	37	F	7.18
47	Vetrivel	Prolene	32	M	7.33
48	Muttulakshmi	Prolene	25	F	6.45
49	Selvi	Prolene	45	F	6.54
50	Keerthana	Prolene	33	F	7.33

Sl No	Name		MODIFIED HOLLANDER SCORE				SOUTH HAMPTON SCORING			
			POD 3	POD 7	POD 30	6 Months	POD 3	POD 7	POD 30	6 Months
1	Pushpammal	Glue	4	4	4	4	0	0	0	0
2	Veerammal	Glue	4	4	4	4	0	0	0	0
3	Sumathy	Glue	4	4	4	4	1a	0	0	0
4	Pandirani	Glue	4	4	4	4	0	0	0	0
5	Petchi	Glue	4	4	4	4	0	0	0	0
6	Pandiyammal	Glue	4	4	4	4	0	0	0	0
7	Indumathy	Glue	4	4	4	4	0	0	0	0
8	Karthik	Glue	4	4	4	4	0	0	0	0
9	Subbulakshmi	Glue	2	3	4	4	1c	1a	0	0
10	Rajalakshmi	Glue	4	4	4	4	0	0	0	0
11	Anushya	Glue	4	4	4	4	0	0	0	0
12	Murugayammal	Glue	4	4	4	4	0	0	0	0
13	Meenakshi	Glue	4	4	4	4	0	0	0	0
14	Kaliyammal	Glue	4	4	4	4	1a	0	0	0
15	Balasubramanian	Glue	4	4	4	4	0	0	0	0
16	Thangapandiyammal	Glue	3	4	4	4	1c	1a	0	0
17	Palaniyammal	Glue	4	4	4	4	0	0	0	0
18	Saroja	Glue	4	4	4	4	0	0	0	0
19	Meenatchi	Glue	4	4	4	4	1a	0	0	0
20	Sulochana	Glue	4	4	4	4	0	0	0	0
21	Savitha	Glue	4	4	4	4	0	0	0	0
22	Vasanth	Glue	4	4	4	4	1a	0	0	0
23	Mahalakshmi	Glue	4	4	4	4	0	0	0	0
24	Uma shanti	Glue	4	4	4	4	0	0	0	0
25	Jayalatha	Glue	4	4	4	4	0	0	0	0
26	Veena	Prolene	4	4	4	4	1c	1a	0	0
27	Jayalakshmi	Prolene	4	4	4	4	1a	0	0	0
28	Pushpammal	Prolene	4	4	4	4	1a	0	0	0
29	Vishalini	Prolene	4	4	4	4	1c	1a	0	0
30	Rachana	Prolene	4	4	4	4	0	0	0	0
31	Ramalakshmi	Prolene	4	4	4	4	1a	0	0	0
32	Sheela	Prolene	4	4	4	4	0	0	0	0
33	Sasikala	Prolene	2	3	3	3	2b	2b	0	0
34	Poomayil	Prolene	4	4	4	4	0	0	0	0
35	Kaveriyammal	Prolene	4	4	4	4	1a	0	0	0
36	Yogeshwaran	Prolene	4	4	4	4	1c	1a	0	0
37	Kamatchi	Prolene	3	4	4	4	2b	1c	0	0
38	Nirmala	Prolene	4	4	4	4	1a	0	0	0
39	Divya	Prolene	4	4	4	4	0	0	0	0
40	Suganya	Prolene	4	4	4	4	1a	0	0	0
41	TamilSelvi	Prolene	4	4	4	4	0	0	0	0
42	Muttumari	Prolene	2	3	4	4	2b	1c	0	0
43	Lingammal	Prolene	3	3	3	3	2b	2b	0	0

44	Velmurugan	Prolene	4	4	4	4	1a	0	0	0
45	Poomayil	Prolene	4	4	4	4	1c	1a	0	0
46	Ester julie	Prolene	4	4	4	4	0	0	0	0
47	Vetrivel	Prolene	4	4	4	4	1c	1c	0	0
48	Muttulakshmi	Prolene	4	4	4	4	1a	0	0	0
49	Selvi	Prolene	4	4	4	4	0	0	0	0
50	Keerthana	Prolene	4	4	4	4	0	0	0	0

ABBREVATIONS

OCA: Octylcyanoacrylate Glue

POD: Post Operative Day

SSI: Surgical Site Infections

TRH: Thyrotropin Releasing Hormone

TSH: Thyroid Stimulating Hormone

DTC: Differenciated Thyroid Carcinoma

FTC: Follicular Thyroid Carcinoma

Tg: Thyroglobulin

ANTI PLIAGRISM CHART

URKUND

Urkund Analysis Result

Analysed Document:	Dr. Akshay P R Thesis.docx (D42493746)
Submitted:	10/12/2018 7:40:00 PM
Submitted By:	akshaypr007@gmail.com
Significance:	4 %

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ANTI PLIAGRISM CERTIFICATE

CERTIFICATE - II

This is to certify that this dissertation work titled ***COMPARATIVE STUDY REGARDING THE USE OF CYANOACRYLATE GLUE AND SUBCUTICULAR SUTURES IN THYROIDECTOMY WOUND CLOSURE*** *o*f the candidate Dr. Akshay P R with registration Number 221611101 for the award of Master Degree in the branch of General surgery. I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows 19 percentage of plagiarism in the dissertation.

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Name of the Candidate	:	Dr.Akshay P.R
Course	:	PG in MS., General Surgery
Period of Study	:	2016-2019
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	A comparative study regarding the efficacy of cyanoacrylate glue v/s subcuticular sutures in thyroidectomy wound closure
Ethical Committee as on	:	23.01.2018

The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted.

M.Shanthi

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